SCIENTIFIC AMERICAN
No. SUPPLEMENT 124

Scientific American Supplement, Vol. V, No. 124.
Scientific American, established 1845.

NEW YORK, MAY 18, 1878.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE CAÑONS OF THE COLORADO.*

[Compiled from the Report of Prof. J. W. Powell, Geologist, in charge of the Geological and Geographical Survey of the Territories.]

LEAVING the Land of Standing Rocks, Fig. 14, and still proceeding southward, we encounter Glen Cañon as the next object of interest. Its entire course is through rocks of Triassic age, chiefly red sandstones. These rocks, beautifully exposed in the Orange Cliffs, return to the river down the western bank of the Dirty Devil, and we enter them again immediately below the mouth of that stream.

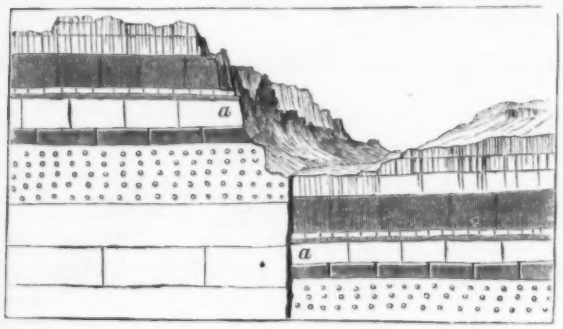


FIG. 16.—A SIMPLE FAULT.

One feature of great interest in this cañon is the caves, formed by the washing out of soft strata. Away from the river on either side are broad stretches of naked sandstone, carved by the rains into gentle billows or mounds. As the rains gather into streams the grooves between the mounds become gulches, and the gulches in turn become cañons. When in this process of corrasion the streams cut down into softer strata, the channels widen in a curious manner. The streams are everywhere tortuous, and, as is usual with rivers, the constant corrasion of the banks increases the sinuosities of their course, so that as these streams cut downward they also cut sidewise, undermining the walls on the outer sides of curves, making overhanging cliffs with vertical outlines as irregular and waving as the horizontal. Occasionally streams are found which have encountered softer strata above and harder below. The walls of these cañons are flaring, as well shown by Fig. 15. The head of Glen Cañon is at the mouth of the Dirty Devil River, and its foot at the mouth of the Paria, where it abruptly terminates in the Vermilion Cliffs. See map on page 1918, SUPPLEMENT, No. 121.

The cliffs due to erosion, such as the Brown, Book, and Orange Cliffs, have been noticed, but we have now to consider numerous cliffs formed by *faults*, and the several kinds of faults and folds to be found are shown by Figures 16 to 23.

The Kaibab Plateau is twenty-five or thirty miles wide and about eighty miles in length. It is the most elevated part of the country, well defined on the east and the west by steep slopes and lines of cliffs formed by displacements, on the south by the chasm of the Colorado, and on the north it abuts against the Vermilion Cliffs. From this central portion the general surface of the country drops by successive faults or folds to the east and west. In the region now to be described the Colorado runs nearly west, and the section of the country shown in Fig. 23 is also taken east and west. A few score miles of the river are seen on the right. The first cliffs to engage attention are the Echo Cliffs. They form a sharp ridge, and are, in fact, two parallel lines of cliffs, one facing the east, caused by erosion, and the other, formed by folding, facing the west. This Paria Fold will be more fully noticed hereafter.

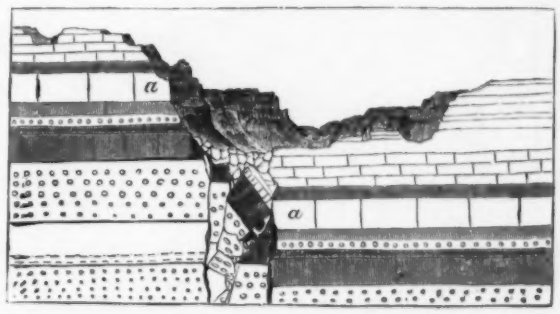


FIG. 17.—FAULT WITH WALLS WIDELY SEPARATED, THE INTERVENING SPACE FILLED WITH BROKEN ROCKS.

Traversing a barren plain for thirty-five or forty miles, and crossing Marble Cañon, we arrive at the first eastern Kaibab fold, from fifteen to eighteen hundred feet high; then there is a bench three or four miles wide, then the second eastern Kaibab fold, fifteen hundred feet high. To the south of the section here shown these eastern Kaibab steps have escarpments, as the displacement is by faulting. To the north, in the vicinity of the section shown, they have slopes, as the displacement is by folds. The Kaibab Plateau is here 8,000 feet above the sea. The clouds yield their snows even in July in this upper region, and the moisture has disintegrated the rocks and formed a soil which supports vast pine forests. Springs abound, beautiful lakes occur, verdant meadows give pasturage for herds of deer. This is the summer home of the Kai-vav-its Indians.

The next cliffs in order are the To-ro'-weap Cliffs, bounding the Kanab Plateau on the west. Here is another drop of eight hundred feet. The country west of these escarpments consists of volcanic cones and sheets of basalt and beds of cinders. The boundary of this region is Hurricane Ledge, where there is a drop of more than two thousand feet. It presents an impassable barrier to the traveler, except where narrow cañons are cut here and there, and

FIG. 14.—LAND OF STANDING ROCKS, SHOWING THE REMARKABLE EROSION CAUSED BY RAINS.

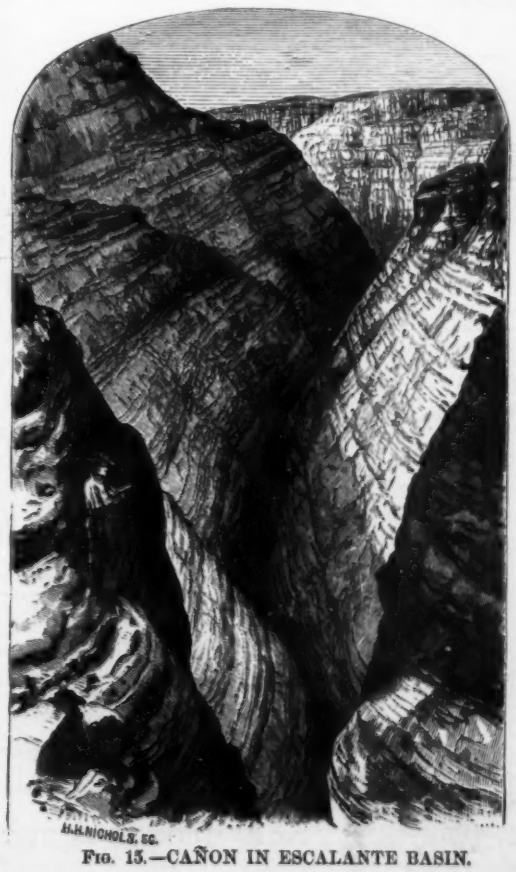


FIG. 15.—CAÑON IN ESCALANTE BASIN.

THE CAÑONS OF THE COLORADO RIVER.

* Continued from page 1919, SUPPLEMENT, No. 121.

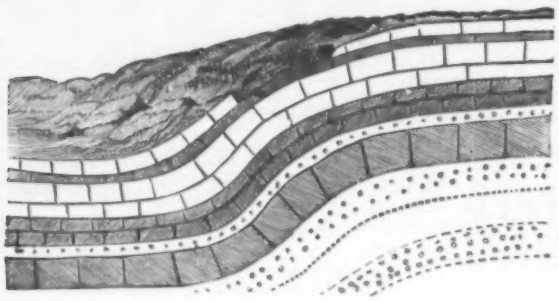


FIG. 18.—A MONOCLINAL FOLD.

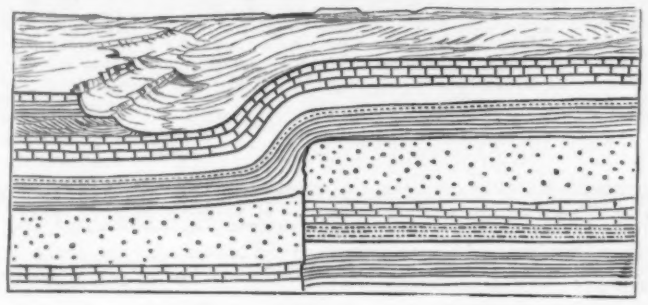


FIG. 19.—FAULT AND FOLD COMBINED.

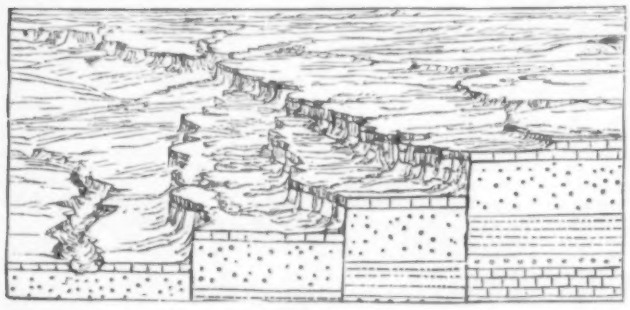


FIG. 20.—A BRANCHING FAULT.

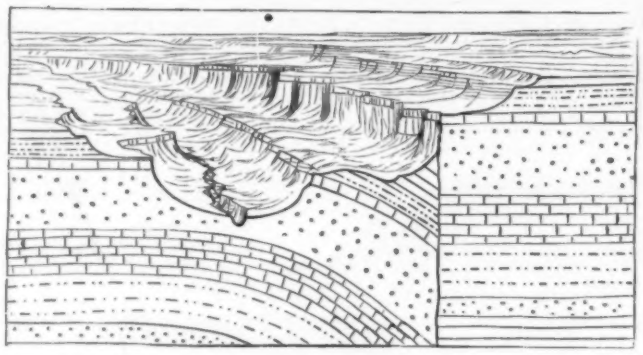


FIG. 21.—FAULT WITH THROWN BEDS FLEXED DOWNWARD.

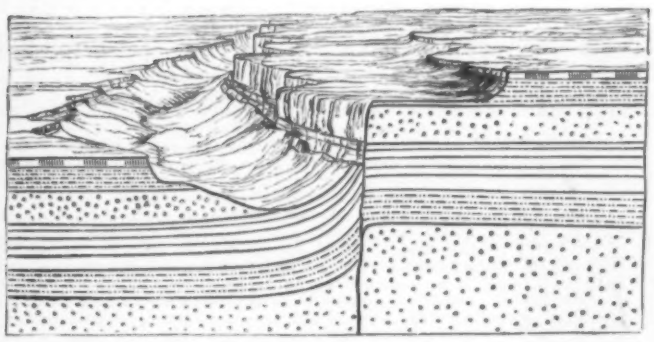


FIG. 22.—FAULT WITH THROWN BEDS FLEXED UPWARD—A DRAGGED FAULT.

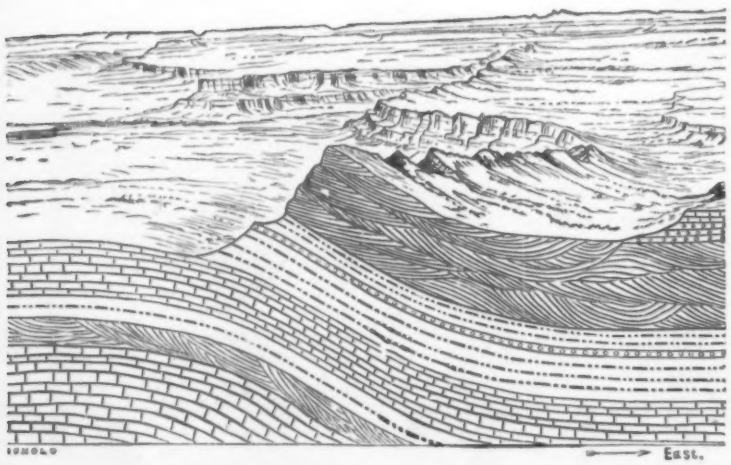


FIG. 26.—SECTION THROUGH ECHO CLIFFS.

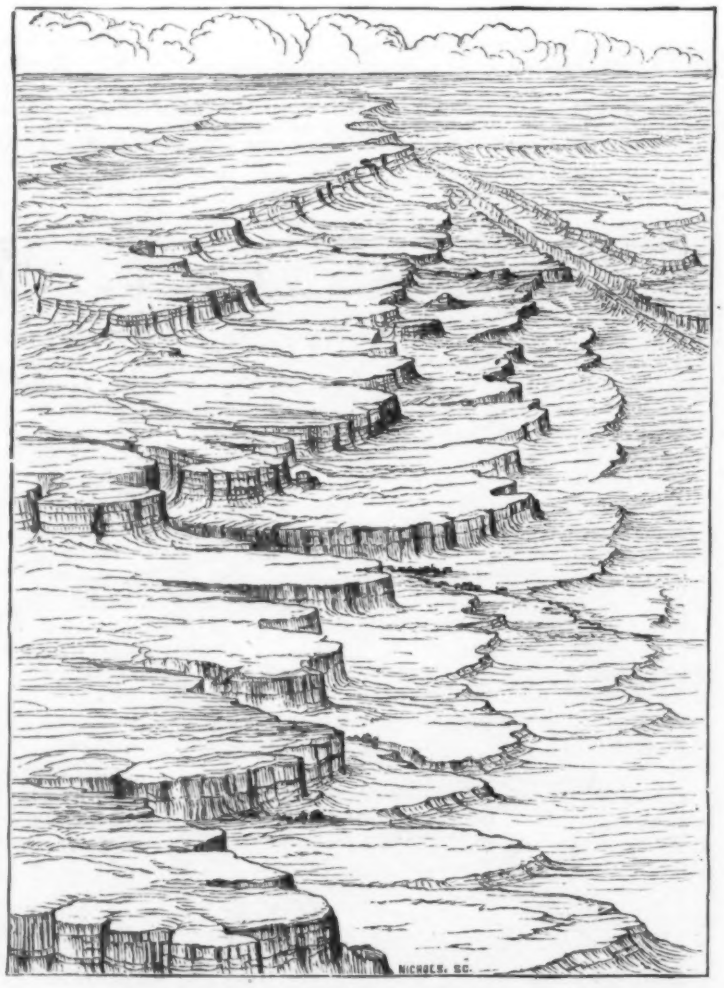


FIG. 24.—BIRD'S-EYE VIEW OF CLIFFS OF EROSION, SHOWING THE SHINARUMP CLIFFS, VERMILION CLIFFS, AND GRAY CLIFFS, IN ORDER FROM RIGHT TO LEFT.

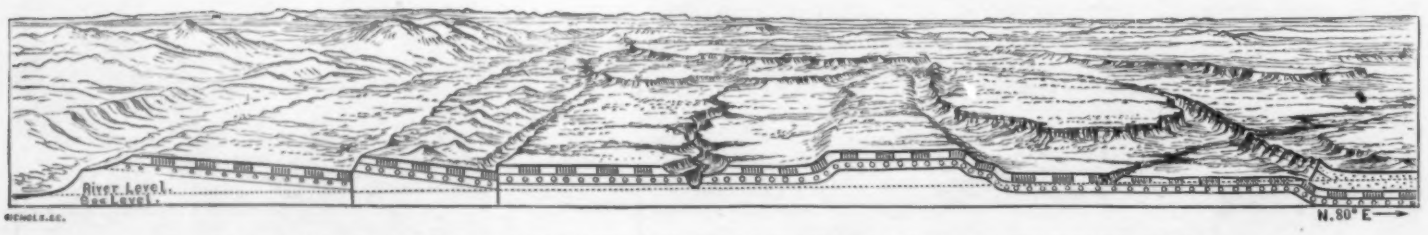


FIG. 23.—SECTION FROM WEST TO EAST ACROSS THE PLATEAUS NORTH OF THE GRAND CAÑON.

THE CAÑONS OF THE COLORADO RIVER.

where, in two or three places, volcanoes standing on the plateau above have poured streams of lava over the edge of the cliffs, forming a rugged slope which may be climbed with difficulty. Next comes the Shi'-wits Plateau, a barren, naked region. Here and there springs burst from beneath the basaltic cliffs, and deep gulches and cañons are cut by the streams. About these springs and in the deep gulches the Shi-wits Indians live, cultivating little patches of corn, gathering seeds, eating the fruits and fleshy stalks of cactus plants, and catching a rabbit or a lizard now and then; and terminates the elevated part of the Colorado River basin. The remaining two-thirds of the river, from the Grand Wash to the Gulf of California, flows through a generally lower region of which nothing need be said. The valley of the Grand Wash is a desert of broken rocks and naked sands. There are two or three springs in the valley, where squalid Indians live, in a climate so warm and arid that they build themselves no shelter. In the Grand Wash the summit of the Carboniferous rocks is deeply buried beneath sandstones and shales of a later origin.

FIG. 25.—BIRD'S-EYE VIEW OF CLIFFS OF EROSION THROWN FORWARD BY A FAULT.

dirty, squalid, but happy, and holding their barren land the Eden of the earth.

In the region above the Hurricane Ledge are extensive grazing lands, and where there are a few springs for irrigation the Mormons raise the products of a temperate climate. Below the Ledge, along the Virgen and Santa Clara rivers, are two or three small towns, where the inhabitants cultivate subtropical products, and a stone may be thrown from the land of the potato and apple to the land of the fig and sugar cane.

The Grand Wash fault consists of two cliffs, the lower 1,500 or 1,800 feet high, and the upper 1,000 feet or more. The Grand Wash Valley is at the foot of the Grand Cañon,

The upper surface of the district adjacent to the Grand Cañon is the summit of the rocks of the Carboniferous age, but north from forty to sixty miles we find rocks of a later origin in four lines of cliffs facing the south. Going north from the Grand Cañon the Shin-ar'-ump Cliffs, with a capping of conglomerate, are first met; then the Vermilion Cliffs, with harder rocks above and softer below; next come the Gray Cliffs, with a gray homogeneous sandstone at the base, capped by limestone containing Jurassic fossils. These three lines of cliffs are represented in Fig. 24. The next escarpments encountered in our northward progress are the Pink Cliffs, so called because stained by oxide of iron. The numerous hills to the south of these cliffs are carved out of strata of Cretaceous age. The cliffs are capped by rocks of Tertiary origin. The ascent from the base of the Shin-ar-ump Cliffs to the summit of the Pink Cliffs is but 4,000 feet, but as the dip is toward the north, the thickness of the beds here coming to the surface is as much as 10,000 feet.

Though in general these cliffs trend east and west, their direction is varied by faults in the following peculiar manner. Wherever a north and south fault is found, the block which has been thrown down has its lines of cliffs carried southward, or toward the axis of upheaval, or, if we are to consider the displacement as caused by upheaval, the blocks uplifted have their lines of cliffs set farther back to the north; and the amount of this backward forward displacement is in direct ratio to the amount of vertical displacement in the fault or monoclinal fold. The higher region has suffered more erosion, so the cliffs of the higher blocks stand farther back from the axis of upheaval than those of the lower blocks. (Fig. 25.)

Not only are there great benches caused by faults, running north and south, but there are other benches running east and west, due to erosion.

The cliffs of erosion are very irregular in direction, but somewhat constant in vertical outline; the cliffs of displacement are somewhat regular in direction, but very inconstant in vertical outline. This inconstancy is due to the frequent changes in the character of the fault, as previously suggested by Figs. 16 to 22.

In the Echo Cliffs, Fig. 26, a line of cliffs of erosion and a slope of displacement are placed back to back. The position of the latter is essentially permanent, but the cliffs of erosion have probably been carried back to their present position from Marble Cañon by the ceaseless denudation of the rains. Where the fold begins the erosion of the strata gradually ceases, for it is apparent that the rains cannot wash out strata situated below the level of the surrounding surface. Hereafter the action of the water upon the Echo Cliffs will be in wholly obliterating the ridge.

(To be continued.)

FIG. 27.—BIRD'S-EYE VIEW OF THE GRAND CAÑON LOOKING EAST FROM THE GRAND WASH. ONE BIRD, ECHO CLIFFS; TWO BIRDS, KAIBAB PLATEAU; THREE BIRDS, TO-RO'-WEAP CLIFFS; FOUR BIRDS, HURRICANE LEDGE; FIVE BIRDS, SHI-WITS PLATEAU.

THE HOT SPRINGS, BATH COUNTY, VIRGINIA.

THIS famous medical fountain, one of the great natural curiosities of America, is situated in the beautiful valley that lies at the western base of the Warm Springs Mountain, in Bath county, Va. It is approached from either Millboro' (twenty miles distant), or Covington (eighteen miles distant), on the Chesapeake and Ohio railroad, over finely graded turnpike roads, and except that short distance, has an unbroken railroad connection with the principal cities on the Atlantic seaboard. It can be reached from New York in almost twenty four hours, and from Washington city in but little over twelve.

Within the grounds are found, in close proximity, numerous bold springs of hot and cold mineral water, ranging in temperature from 50 to 110 degrees Fahrenheit.

The different *Hot* Springs make their appearance in a line extending from the base of the mountain almost straight down a lawn in front of the hotel, the soil of which has the appearance of having been washed out of the base of the mountain to its present locality, and is highly charged with carbonates of the alkaline earths.

The flow from the springs is a constant and regular current with *unchanging* temperature; arising from great depth, the contingencies that control surface springs do not influence them.

The Boiler Baths are supplied by numerous hot springs which issue from the earth under the floor of the pools at a temperature of 110 degrees Fahrenheit, and retaining a permanent standard of 106 degrees in the full bath. Suitable machinery has been provided, by means of which invalids who cannot walk or stand without inconvenience, may be lowered into the bath, either in a recumbent or sitting posture.

The mineral constitution of these baths, as determined by the analysis made by Col. Wm. Gilham, of the Virginia Military Institute, is as follows:

One gallon of water contains of

Carbonate of lime	17·3471	grains.
" of magnesia	2·6873	"
" of protoxide of iron	0·1139	"
Sulphate of lime	1·7357	"
" of magnesia	5·6589	"
" of potassa	1·3431	"
" of soda	1·0222	"
Chloride of potassium	0·1597	"
" of sodium	0·1211	"
Silica	1·7467	"

The Sulphur Baths are supplied from a remarkably bold spring of 102 degrees temperature.

The mineral contents in a gallon of the water are as follows:

Carbonate of lime	16·4434	grains.
" of magnesia	2·8037	"
" of protoxide of iron	0·0670	"
Sulphate of lime	2·1039	"
" of magnesia	5·1052	"
" of potassa	1·8240	"
" of soda	1·0087	"
Chloride of potassium	0·1703	"
" of sodium	0·1335	"
Silica	1·3673	"

In this analysis no notice is taken of gaseous contents, but the presence of a notable amount of sulphureted hydrogen is unmistakably revealed by the odor apparent at the source, and there is, moreover, a white sulphurous deposit very similar to that seen at the celebrated Greenbrier White Sulphur Springs.

The Octagon Bath is supplied by one of the boldest springs on the grounds. The water rises from the floor of the bath at a temperature of 100 degrees, highly charged with carbonic acid, nitrogen, oxygen, and sulphureted hydrogen gas, which, bursting to the surface in thousands of bubbles, makes the water sparkle like a glass of wine. The bath is twenty-five feet in diameter and five feet in depth. The water is very buoyant, and the effect of the bath is highly exhilarating. The size of the pool affords abundant room for the enjoyment of the novelty and luxury of a swimming bath in hot water.

The diseases supposed to be benefited are rheumatism, gout, neuralgia, paralysis, scrofula, syphilis, affections of the skin, affections of the digestive canal, diseases of the liver and portal system, diseases of the kidneys and bladder,

urethral stricture, uterine diseases, diseases of the nervous system, etc.

The Warm Springs Valley presents certain peculiarities of formation which greatly enhance the beauties of its scenery and contribute to the well-known salubrity of its climate. Lying between two parallel mountain ranges, whose general course is from northeast to southwest, it is intersected at short intervals by secondary valleys, which convey the mountain water-courses through correspondent gaps in the western range into Jackson's River. This insures the more perfect drainage and ventilation, by which this valley is distinguished from any other in the same section of the State, and opens on the west vistas of incomparable beauty. The Hot Springs are found at the head of one of these intersecting valleys, and the hotel is so situated as to command the finest view in both directions and to catch the summer breeze from every quarter.

The climate in summer is salubrious, invigorating and inexpressibly delicious. The thermometer seldom rises higher than 85 degrees F. in the hottest days, and the nights are always cool and refreshing. Fogs, which occur so frequently in other settlements among the mountains of this part of Virginia, are seldom seen in this delightful valley, which, in the transparent clearness of the atmosphere and the exquisite tints of its skies, exhibits some of the distinctive features of Swiss and Italian scenery.

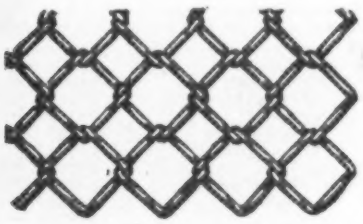
The surrounding heights of the Warm Springs Mountain attain, in many places, an elevation of nearly two thousand five hundred feet above the level of the sea, and afford the most extensive and imposing mountain scenery in America. Toward the west are the rugged peaks of the Alleghany ranges, wild and romantic in appearance, and standing thick and close like great billows of an ocean, while far toward the east the gentler slopes of the Blue Ridge and numberless beautiful valleys attract and charm the eye of the spectator.

ERUPTION OF MOUNT HECLA.

On the 27th of February, about seven o'clock in the evening, an eruption commenced at Mount Hecla. "Two hours previously," writes Dr. Hjaltalin to us from Reykjavik, under date March 22, "there was a severe earthquake, which was slightly felt here at Reykjavik, about fifty English miles distant, but we hear more seriously in the neighborhood of this volcano, and even to an extent of ten English miles all around. This eruption still continues, as the flames often are visible in the evening, even from our town. But, owing to the great difficulty of traveling in Iceland at this time of the year, the man I sent to report about it has not yet returned; hence detailed accounts cannot be given until by next boat. From a clergyman who lives very near the mountain I have got a small sample of the ashes thrown out by the eruption, and in comparing it with the ashes which the same mountain vomited in 1845 I find it to be the same mineralogically. It is a black basaltic, or rather augitic, ash, which may prove very hurtful, and has done so to herbage, especially in the neighborhood of the mountain. Previous eruptions of Hecla have been very terrific, both in aspect as well as results, to the Icelanders, although they have not all proved equally dangerous. But especially round the mountain the damage has been more or less felt as the eruption each time was large or small. There has been some dispute among historians and other learned men how many eruptions have occurred from Hecla during the historic time. Last century, when the learned travelers, Dr. Bjarni Pálsson and Eggert Olavsson, traveled through Iceland, they reported that in the historic time twenty-two eruptions occurred from the mountain itself and three from its annexes. Two eruptions have since occurred, so that this one would be the twenty-eighth. Some of the theoretical geologists who visit us sometimes assured us a short time ago that we might rest assured that Hecla would not trouble us again." In a private letter it was stated that "the eruption was close to the north-east side of the mountain. The earthquakes which preceded it were very violent, and as soon as it was dark the sky in the direction of Hecla seemed quite aflame. Fortunately, the ashes have, as a general rule, been carried northward and eastward into the deserts. The eruption is still (March 24) going on with undiminished force."

TORPEDO GUARD.

We illustrate herewith an arrangement of defensive armor, specially intended to guard against the attack of fish torpedoes discharged from steam launches. It will be seen that the defensive armor consists of a chain curtain running the whole length of a ship at each side, and so carried by lifting davits that it can be raised the moment a ship has to be moved, and lowered with yet more rapidity when

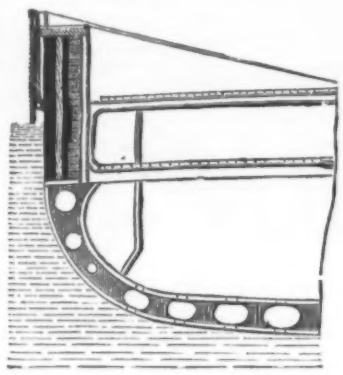


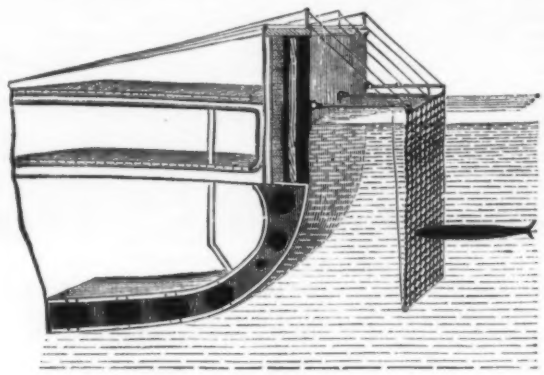
the ship drops anchor or otherwise comes to rest in dangerous waters. An enlarged view of the chain armor is given above. The principal cut is a broken cross section of the Inflexible.

The chain curtain would, it may be urged, be inoperative in a heavy sea, but so would be both launch and torpedo; a sea indeed which would make an ironclad at anchor only move gently would render it impossible for a launch to take any aim. The curtain can always be kept out from the ship's side by a slight alteration, viz., carrying the davit beyond the curtain outward and running down a guy from this prolongation to the foot of the curtain. A convenient distance at which to suspend the chain curtain from the ship's side may be taken as 10 feet to 12 feet, and at this distance there is reason to believe that no charge of dynamite or gun cotton which small fish torpedoes could carry would be capable of bursting in the double bottom of a man-of-war.—*Engineer.*

IMPROVED BREECH-LOADING MECHANISM.

The arrangement of breech-loading mechanism for field guns, which we illustrate below, is one designed by Mr. R. J. Johnson, and its special feature consists in closing the breech end of the gun with a breech block of rectangular shape and parallel sides, secured against the bore of the gun by a strong hollow screw, which also serves to work the breech block horizontally in and out of the side of the gun by means of a pin on the end of the screw and a slot cut in the rear of the breech block. With this arrangement a little more than half a turn of the screw opens the gun for loading, and the same simple movement closes it for firing. Figs. 1 and 2 show the position of the mechanism when the gun is open for loading. Fig 3 is an outside view of the rear end of gun ready for firing. Figs. 4 and 5 are views of the breech block.





IMPROVED TORPEDO GUARD.

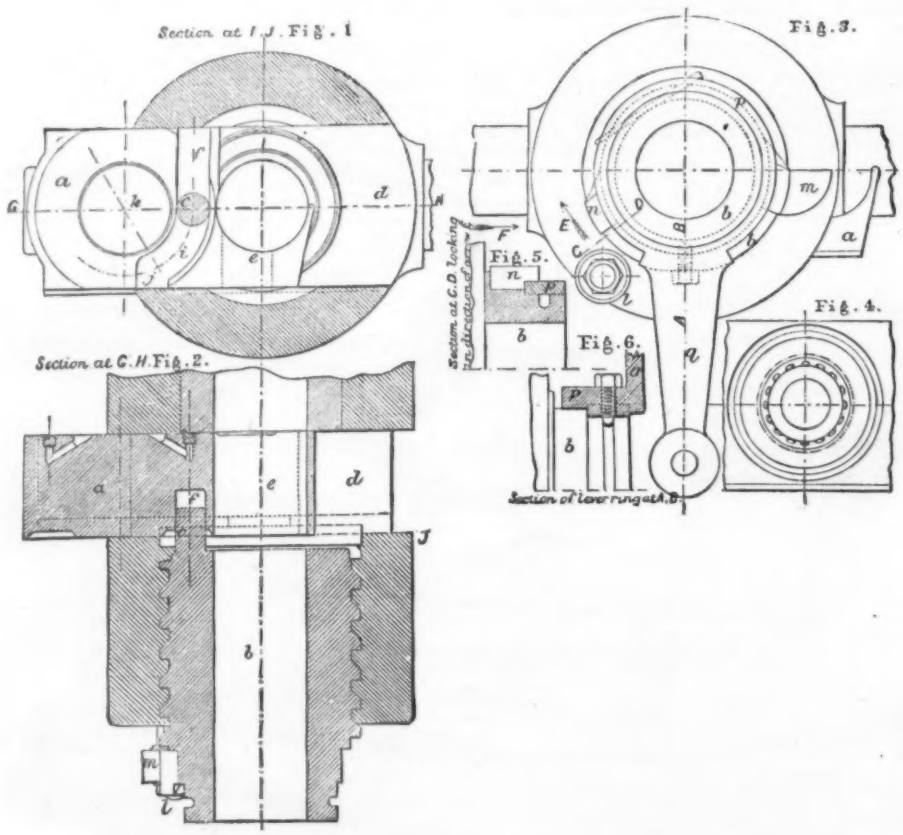
In the illustrations, *a* is the breech block; *b*, the screw; *e*, the pin on end of screw, forming one solid mass with the screw; *d* is the horizontal chamber cut through gun from side to side at right angles to the bore, and in which works the breech block; *c* is a projecting part of breech block to pass the charge over the bottom of breech block chamber when loading; *f* is the slotway cut in the rear of breech block, in which the screw pin works; *l* is the stop; *m* and *n* are the starting pieces, and form part of the screw; *m* serves also to act against stop, *l*; *p* is the lever ring, forming one piece with the lever, *q*.

The mechanism works thus: To open the gun the lever, *q*, with the ring, *p*, is turned sharply till it meets the starting piece, *m*; the shock produced starts the screw. Now, the screw being engaged to the amount *g h* in the breech block, it must be withdrawn that amount to be clear of the breech block before the breech block can be moved; that is done when the mechanism is put together. The lever ring is made to work partly under the starting pieces, *m n*, as shown by the sections of lever, ring, etc., in order to get all the mechanism at the rear of the gun as near the gun as possible.

In this system of breech-loading the gun is of wrought iron with a steel tube, the breech block is of steel, the screw of phosphor-bronze, and the lever ring and lever of wrought iron. This system is not applicable to larger guns than a 20-pounder, as the mechanism for a larger gun would be too difficult and heavy to work.—*Engineering.*

THE SHELL TRIALS AT SHOEBURYNESS.

A few evenings ago, in the House of Commons, Mr. W. H. Smith was asked what would be done with the Whitworth guns and projectiles of the Independencia, now the Neptune,



IMPROVED BREECH-LOADING MECHANISM.

while the pin is traveling in the circular part, *i*, of the slotway, *f*, which circular part has its center at *k*, the center of gun and screw likewise. The screw is made to enter the breech block to the amount *g h*, in order to secure the breech block more thoroughly and to prevent all lateral movement when gun is fired. As soon as the pin reaches the horizontal center line it acts upon the breech block, which it moves out of the gun clear of the bore in half a revolution of the screw, and we then have the gun open. Now, when the screw and the breech block reach the end position the movement of the screw must be stopped immediately, for if its movement was continued it would work the breech block into the gun again. To effect the stoppage of the screw at the right moment a strong bolt, *l*, is screwed into the rear of gun, and on the end of the bolt is secured a thick ring of India-rubber; thus as soon as the screw has attained the end position the piece *m*, forming a solid mass with the screw, strikes the bolt or stop, *l*, and thus stops the screw, the India-rubber ring prevents the shock from being injurious to the mechanism. To close the gun the lever is turned back again till it meets the piece *n*; the screw and breech block then begin to move: half a revolution of the screw then brings the breech block into its right position to close the gun for firing, and the movement of the breech block then stops, while that of the screw continues, in order to enter the breech block the amount *g h*, the screw pin in the meanime traveling in the circular part, *i*, of slotway, *f*, as when opening gun. The extra length, *j*, of the slotway in breech block is to enable the screw to make an entire revolution with the screw pin in the breech block and he replied that the whole armament would be left unaltered until its powers had been fully tested. The significance of this reply has been rendered apparent by some recent experiments at Shoeburyness, which were noticed in our Naval and Military Intelligence, and which have been set on foot for the purpose of testing the relative values of different kinds of shell for the specific purpose of piercing armor plates, without sacrifice of their power subsequently to inflict injury by explosion. In order to realize the full importance of the results of these experiments, it is necessary to bear in mind what it is that a perfect shell should be able to accomplish. In the first place, it should expend its whole momentum, or, in other words, the whole of the force

derived from the charge by which it was fired, in penetrating the armor-plate against which it strikes; and when that has been done it should still produce further destruction by the explosion of the bursting charge contained in its interior. It follows that the principal qualities to be desired in an armor-piercing shell are—first, sufficient strength of material to enable it to penetrate deeply without sustaining fracture; and, secondly, sufficient internal capacity to contain a large bursting charge, which may produce the *maximum* of destruction after the penetration is complete. The mere power of penetration is of small importance when taken alone, and almost any shell will penetrate armor to a certain extent. The momentum communicated by the original charge is not lost by fracture, but is merely distributed among the fragments, so that, although a shell may be broken up at the moment of impact, the momentum of its parts will be sufficient to carry them to a considerable depth. It has been shown by experiment, for example, that a nine-inch chilled-iron shell will be broken by striking against a three-inch plate; but yet such a shell will penetrate at least eleven inches into a twelve-inch plate, and will cause a fracture on the other side, although it does not absolutely pass through. There can be no doubt that the shell is broken up either at the moment of contact or very soon afterward, and that the penetration is effected by the combined action of the fragments, which retain the momentum of the original mass.

Notwithstanding any penetration which may be thus effected, the value of the disintegrated fragments, regarded as a shell, is almost entirely destroyed. The bursting charge, on exploding, will necessarily expend its force in the direction of the least resistance, and this, of course, will be in the direction of the broken base; so that the destructive power, as against the ship or the battery struck, will be reduced to a *minimum*. It has been by losing sight of this most important element in the question that our authorities have been induced to place reliance upon the chilled-iron shell. In estimating the results of experiments they have been content to accept the depth of the hole in the target as the measure of the value of the projectile, forgetting that mere penetration as regards shells is only a preliminary to the most important part of their work. The advocates of the chilled-iron shell have even urged that its tendency to break up is an advantage, on the ground that, on penetration, it produces a shower of fragments, or *mitraille*, which would possess a most destructive character. This may, no doubt, be true under some conditions, but only if the shell were fired against armor which it could penetrate without complete expenditure of its momentum, so that the fragments might have force left with which to inflict injury after passing through. Even then it would be necessary to the argument that the point struck should be on the fighting deck of a ship, or at a place where there were men to be killed or wounded; for in the event of the shell striking anywhere else it would only make a hole somewhat larger than its own diameter—a hole which would be of little consequence if it were above the water-line, and near which there would be no one for the fragments to hurt. The value of the projectile as a shell would be practically destroyed as soon as it was broken, in consequence of the opportunity afforded by the fracture for the comparatively harmless explosion of the charge; and hence, whenever penetration is not complete, a chilled-iron shell is an almost innocuous missile, or, at least, is not more destructive than a solid shot of the same diameter. It has just been shown at Shoeburyness, on the other hand, that a nine-inch steel shell will pass uninjured through twelve inches of armor-plating, and will still retain sufficient momentum to bury itself deeply in the wood backing, so that, after doing all its work as a merely penetrating agent, it would remain imbedded as a mine in the side of a ship, and would inevitably produce, by the explosion of its bursting charge, a very terrible effect. If we suppose such a shell to be filled with gun-cotton and to be imbedded three or four feet above the water-line, it is manifest that the effect of its charge would be likely to place even the most powerful vessel in a very precarious position. A chilled-iron shell, striking at the same point, might almost be described as harmless, not only because it would fail to pass through the armor, and because its explosive force would be wasted in a backward direction, but also because, in all probability, it would never explode at all. The explosion of the contents of a shell is produced by a "retarded" fuse, which is fired at the moment of impact, but which can be so regulated as to burn for any given time, up to nine seconds, in order to allow the shell to imbed itself before the effect is produced. The retarded fuse, being at the base of the shell, would in all probability be torn from its attachments by the general fracture at the moment of impact, and would be anywhere rather than among the gun-cotton which it was intended to explode. It follows even from this consideration alone that the power of deep penetration without fracture is essential to the full usefulness of these projectiles.

Another point of great importance is the amount of the bursting charge, and this depends, of course, upon the capacity of the cavity of the shell. There are only two ways in which this cavity can be increased for a shell of given diameter—first, by diminishing the thickness of its walls; secondly, by increasing its length. The limit of possible variation in the thickness of the walls is soon attained; for, although the stronger the metal of which the walls are made the thinner they may be, yet a certain amount of strength is indispensable. Increase of length is the only remaining expedient. The service gun fires a shell the length of which is equal to two and a half times its diameter; and, if this length is much exceeded, the correctness of aim becomes impaired, since a quick pitch of rifling is necessary in order to fire a long projectile with accuracy. The Whitworth guns have a quick pitch of rifling, and can, therefore, fire long shells of large capacity. One of the guns now on board the Neptune, a 35-ton Whitworth, was tested last year at Gavre, and, by comparing the results of this trial with the official reports of the performances of the Woolwich 35-ton gun, it appears that the former surpassed the latter in every particular. The projectiles of the Whitworth gun carried precisely double the bursting charge of the Woolwich projectiles, and they possessed 21 per cent. more energy at the muzzle and 24 per cent. more energy at 400 yards. Since the time referred to the power of the Woolwich gun has been increased by a somewhat different method of loading; but this change would tell upon the Whitworth gun with precisely similar effect. The Whitworth gun at Gavre was fired under the service conditions of Woolwich at that period, and the alteration which has been made in these conditions when applied to both the guns would leave the relative merits of the two precisely where they were before. It will be seen from the foregoing considerations that Mr. Smith's resolve to test the armament of the Independencia before altering or discarding it is one which has been more than justified by the event. The recent trials have already shown that this armament is far more powerful than that of any other vessel in the Royal Navy; and they have also shown that the chilled-iron Palliser shell, with which until now the navy has been exclusively armed, is really inadequate to the requirements of modern warfare. In these circumstances it is fortunate that the penetrating power of the flat-headed missile and the enormous endurance of the Whitworth fluid-compressed steel should have been again demonstrated; and it is a matter for no small congratulation that the production of both of them should be due to the genius and the industry of a mechanician of whom England is so justly proud.—*London Times.*

AN IRON WAREHOUSE.

A NOVEL feature in building construction, due in great measure to the present exceptionally low price of iron, has been introduced in the erection of a large warehouse in Manchester, England, which is at present being built for Messrs. John Rylands & Reuben Spencer, from the designs and under the superintendence of Mr. John H. Synde, C. E., of the above city. The building, which, when completed, will cover an area of about 600 yards, consists of three fronts six stories high, the whole of which are constructed of cast iron. The main structure consists of vertical iron standards, 1 foot 9 inches wide and 1 foot 9 inches deep; the cornices and strings are 6 inches wide, and are carried on stretcher beams running between the vertical standards, while the floors are carried by means of cast-iron columns, between which and the vertical standards are cast-iron girders, and the whole framework of the building is thus tied firmly together. The outside decorative features are in the Italian style, and the face, of ornamented cast iron, is hung on to the framework and bolted, but in such a manner that, in the case of the bolts decaying, the ornamental castings will still remain in place. The advantages claimed for this system of building are, with the present price of iron, its cheapness, the great saving of wall-space, and the large amount of wall-space which is procured.

PROCESS OF SINKING OIL WELLS.

GOOD oil territory in the Bradford district can either be purchased or leased, the latter method being more generally adopted, as the rental is usually paid by a royalty amounting to one quarter of the oil production. The ground having been selected, a derrick is erected, and the boiler and engine are set up, care being taken to locate the fires at a sufficient distance from the well and its combustible surroundings to guard against danger of a conflagration.

If the location is on high ground where the rock approaches to within twenty or thirty feet of the surface, an ordinary well is dug to the surface rock, and drilling is then begun. If the well is located in a valley or on bottom land where an alluvial soil has been deposited, it will be necessary to sink a driving pipe previous to drilling. The driving pipe is eight inches in diameter, a quarter of an inch thick, and weighs twenty-eight pounds to the foot. It is cast in sections of from fifteen to twenty feet, threads being run at the ends to admit of screwing the sections together. The first section to be driven is provided with a steel shoe which strengthens the pipe and guards against injury from collision with bowlders.

The pipe is driven down into the earth by a wooden maul weighing about 1,600 pounds, which is worked similar to a pile-driver. The surface rock is usually reached in the Tuno Valley at a depth of two hundred and fifty feet, and the diameter of the hole at the bottom is diminished from eight to six inches. As the driving-pipe is gradually sunk the soil within it is from time to time brought to the surface, by means of a sand pump, water being first poured into the hole to convert the dry earth into liquid mud. After reaching the rock, a drill is introduced, and a hole drilled eight inches in diameter to a depth of three hundred and fifty feet, which will usually be far below fresh water courses. The hole is then six hundred feet deep; into this is introduced an iron casing $5\frac{5}{8}$ inches in diameter and $\frac{1}{16}$ of an inch thick, weighing ten pounds to the foot. The water is then exhausted from the casing by means of a steam-pump, and the pulverized rock dries around the base of the casing and forms a durable packing impervious to water. The rock is then drilled to the oil, the hole being $5\frac{5}{8}$ inches in diameter.

For a distance of one hundred and fifty feet the drill passes through a stratum of slate and soapstone, and then reaches the first stratum of sand, which is usually from twenty to forty feet thick. Should this sand fail to yield sufficient oil, the drilling is continued through a second stratum of soft slate and soapstone to the second sand, which is usually three hundred feet in thickness. Should the second fail, the drill is pushed down through the third stratum of slate and soapstone to the third sand. In the majority of cases in the Bradford district each of the sands will yield oil, and over one half will be flowing wells, the oil being forced to the surface by the ascending gases, which are directed into and confined within the casing-pipe by "gas-packers." No pools of oils are found in the Bradford district, the oil being held in the sand rock, and percolating into the well. A flowing well requires little or no attention, and a pumping well is run but two hours each morning and evening, care being taken not to entirely exhaust the oil, in order to avoid incrustations.

The Buffalo *Daily Express* says the average cost of the thirteen hundred wells now in operation in the Bradford district is four thousand dollars. There are two hundred and sixty new wells now being drilled, and ground has been broken for two hundred and forty more.

A NEW ROCKY MOUNTAIN GOLD MINE.

By WM. F. WHEELER, U. S. Marshal.

CONSIDERABLE excitement prevails just at present over new and rich developments in gold quartz, near Helena. I give you a brief description of what has been done in the district, which has been entirely developed within a year past.

The district is named by the miners the Emma Miller Mining District; is situate 20 miles northwest from Helena, on the very summit of the Rocky Mountain Range, about 7,000 feet above the sea level.

The mine, which has made its owner, N. S. Vestal, suddenly rich, is named the Penobscot. The discovery shaft is situated at the exact summit of the mountains, and ten feet *east* from it the water runs into the Pacific, and ten feet *west* it flows into the Atlantic. This fact is owing to the peculiar curve the mountains make at this point. The general trend of the range is from S. E. to N. W. The shaft sunk at the discovery is 80 feet deep and has yielded Mr. Vestal about $7,000, which has more than paid expenses, and a large body of ore is yet left on the dump to be worked. From this point, running east (on the west side of the range), some 360 feet distant, he has sunk a shaft 40 feet deep, showing a fine body of ore, which is worth about $30 per ton. Most of it lays on the dump. About 350 feet further east (still on the west side of the range), the third shaft is the great bonanza of the district. In 23 days, from January 20th to February 13, five men sunk a shaft 25 feet in depth, the ore from which was worked in a small five-stamp mill and two arastras.

To-day, in L. H. Hershfield's bank, at Helena, the bar cast from the retort weighs 1,118 ozs.; fineness, 730; value, a little over $17,000; not over sixty per cent. of the gold in the rock was saved. The tailings were saved and will be worked over in the spring, when the Fruevanner concentrator arrives. The width of the solid vein at 25 feet deep is 13 feet, and the average value is equal to that which has been worked. The core, about 18 inches wide, is much richer, and has been laid aside. It will assay from one to two thousand dollars per ton in gold, and about $600 per ton in silver, and will not be worked until new and better machinery is erected next summer. The yield will be astonishing.

Mr. Vestal owns the entire lead alone, the Penobscot and its western extension, called the Snow Drift, 3,000 feet in all, which is probably the most valuable mining property in Montana owned by any person. A month ago he was a good deal in debt and considered himself a poor man.

The Penobscot Lead is just over the top of the main range of the Rocky Mountains enough to be in Deer Lodge County, while the extension, the Snow Drift, is in Lewis and Clerk Counties, on the eastern slope.

The Blue Bird Lead, in the same district in Lewis and Clerk Counties, is one and a half mile northeast from the Penobscot, and is owned by Cotter & Co. It has a 90-foot shaft, showing a 9-foot vein and 50 feet of levels; 700 tons of ore have been worked in the last year in the ten-stamp Belmont Mill and five-stamp Courtright Mill, and have given an average of $28 per ton.

One mile northeast from the Blue Bird, in Lewis and Clerk Counties, is the Belmont Lead, owned by Vestal, Stockrider, Labey & Griddell. Three tunnels have been run in on the vein. The highest or upper one is in 175 feet and 125 feet from the surface. The second tunnel is in 230 feet and taps the vein 175 feet from the surface. The third tunnel is in 80 feet and taps the vein 215 feet from the surface. The fourth tunnel has just been started and will tap the vein 315 feet from the surface. During the past year 700 tons of the ore have been worked in the Belmont Mill and yielded in gold $11,507.

The Emma Miller Lead, which gives the name to the district, is owned solely by Captain Sears; has been worked on two years, and has produced $12,000. Ore abundant, and runs $12 to $15 per ton. All has been crushed in an arastra at the mine.

The Stemple district is one and a half mile from the Belmont mine. The principal mine is the Whippoorwill. Has three shafts, 100 feet each in depth, and 500 feet of levels. Has been partly worked for three years in arastras; $18,000 has been taken out. Ore averages $25 per ton; vein is four feet wide.

The Northern Light is the western extension of the Whippoorwill; shaft 116 feet deep, and has 70 feet of levels. Ore averages $25 per ton; yield in the year past, $9,000. Worked in arastra.

This gold district is remarkably rich, and numerous leads have been discovered but not prospected. Next summer a 40-stamp mill will be erected, and hundreds of prospectors will cover the mountains with their work.

HELENA, Montana, Feb. 18, 1878.

—*Engineer and Mining Journal.*

THE COAL QUESTION.

IN a lecture recently delivered on the consumption of coal, the lecturer, if fairly reported, made the somewhat remarkable statement that we could only save coal for the use of posterity by submitting to a higher price in the present. Now, if coal is to be economized by the miners' favorite scheme of reducing the out-put, this is certainly true. But that, in our humble opinion, would be beginning at the wrong end. Our duty is to reduce the consumption of coal by limiting consumption, taking care to get the utmost available benefit out of every pound that we burn. If we do that we may have coal cheaper at present, and yet leave a larger supply for coming generations.

For instance, according to the lecturer, a quarter of the coal raised in Great Britain is devoted to domestic consumption. But it has been sufficiently demonstrated that nine-tenths of the heat produced in our ordinary kitchen and parlor fires is simply wasted, going straight up the chimney without benefiting any mortal. Were we sensible enough to renounce that expensive luxury, the "cheerful fire," with its smoke and dust, and make use of stoneware stoves, we might, at any rate, reduce our consumption of domestic fuel by one-half, and burn, instead of a quarter of the present total out-put of coal as now raised, merely one-eighth.

Now, a decline of one-eighth in the gross consumption of any article rarely fails to effect a fall in price more than proportionate. Hence, by saving for the use of posterity one-eighth of our present annual consumption, we should have at present not dearer but cheaper coal.

Again, eleven-fortieths of the present annual coal supply is devoted to manufactures other than metallurgical. But it is well known that some owners of steam engines using the same class of coal will yet burn twice the weight per horse-power that their neighbors find necessary. Here, then, is scope for economizing another one-eighth of our present out-put.

This, we must add, is the only sensible and legitimate way in which the smoke nuisance can be attacked. It is of little use compelling a manufacturer to consume his smoke, and send out nothing but pale gray clouds, or even invisible vapors.

Unfortunately, sulphurous acid, the most dangerous to vegetation, to stone buildings, and to exposed metallic or textile bodies, of all the products of a coal-fed furnace, is as transparent and colorless as the air itself. Yet the more perfectly you burn coal containing sulphur—and this impurity is seldom entirely wanting—the more sulphurous acid gas you inevitably produce. To reduce this nuisance, therefore, we must minimize the quantity of coal used.

It is a sad sight to see certain self-feeding, smoke-consuming furnaces throwing out, as they revolve, great lumps of coal still blazing, and capable of liberating a great amount of heat. So long as such methods of work are allowed to continue, it seems to us that we are consulting neither our own immediate interests nor those of our posterity.—*Chemical Review.*

MANUFACTURE OF BESSEMER STEEL AND STEEL RAILS.

By C. R. HOLLAND.*

IT is natural to suppose that any person giving a description of the manufacture of Bessemer steel is convinced that the process which he employs is the best. This, however, it is not my intention to claim, nor is it, so far as I can see, the wish of the society which I have now the honor of addressing. The object of our meeting, as I understand it, is the diffusion of that knowledge which is so desirable and so necessary for the benefit of all, and it is on this account that I venture to lay before you a description of the manufacture of Bessemer steel and of Bessemer steel rails, as conducted at the works which I represent—the works of Messrs. Brown, Bayley & Dixon (Limited), Sheffield.

There are many things which we claim, and from which we derive benefit; there are others which, from our position, we feel we are unable to remedy. At the same time, I have pleasure in placing the particulars of our processes before you, and shall be very pleased if the discussion on the subject which follows gives rise to anything of general advantage.

ON THE MANUFACTURE OF BESSEMER STEEL.

The Bessemer plant at the above works consists of two pits, each pit and its appliances including four cupolas for melting pig iron and two for spiegeleisen; a pair of 8-ton converters with hot-blast stoves; an ingot pit with center ladle-lift; a pair of 5-ton hydraulic cranes, and a pair of 1-ton hydraulic cranes.

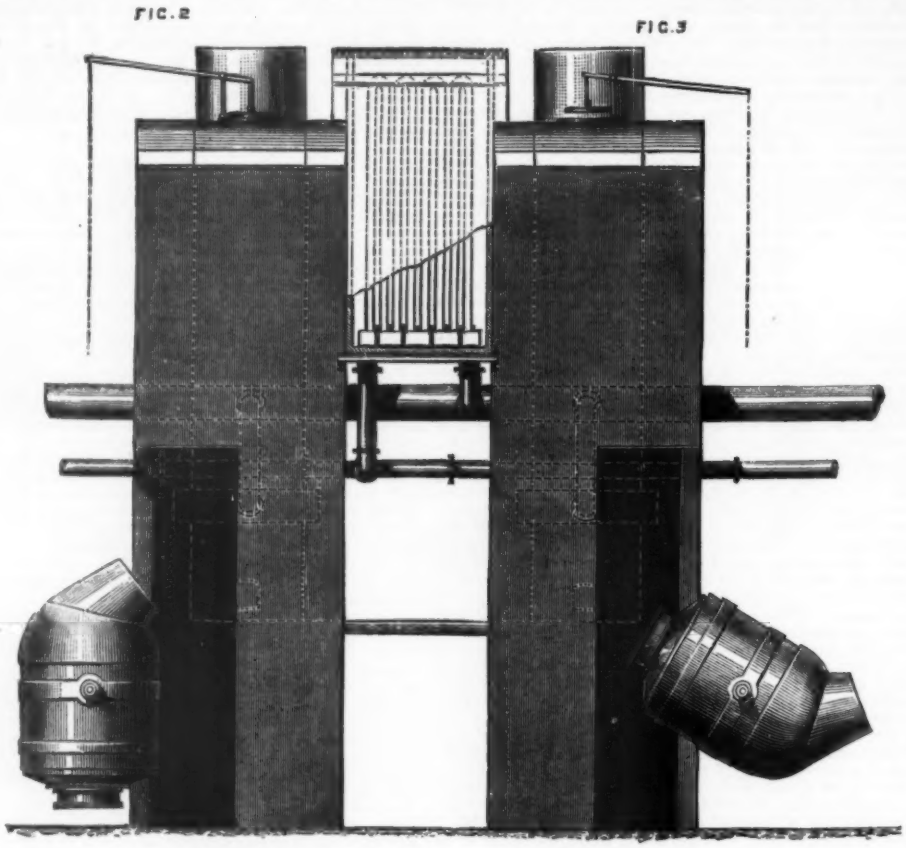
The cupolas for melting pig iron are of 7 feet in diameter inside the casing, and of a total height of 37 feet. There are two rows of tuyeres, one about a foot above the other, three tuyeres of an inside diameter of 5½ inches in each row; the bottom row is placed 5 feet above the tapping hole (and the bottom of the charging hole is 15 feet above this bottom row of tuyeres, or twenty feet above the tapping hole). The lining of the tapping hole to about 4 feet above the top row of tuyeres is of the most siliceous gannister stone that we can procure, the dried sample containing about 93 or 94 per cent. of silica and 3 or 4 per cent. alumina. From this point (4 feet above top tuyeres) upward the lining is of firebrick. The inside diameters of the linings are as follows: At the bottom (tapping-hole level) 5 feet, tapering inward to 4 feet at bottom tuyeres; this diameter is preserved for about 5 feet, or to the top of stonework, from which point it tapers outward to 4 feet 6 at the charging hole, which dimension is maintained to top of cupola.

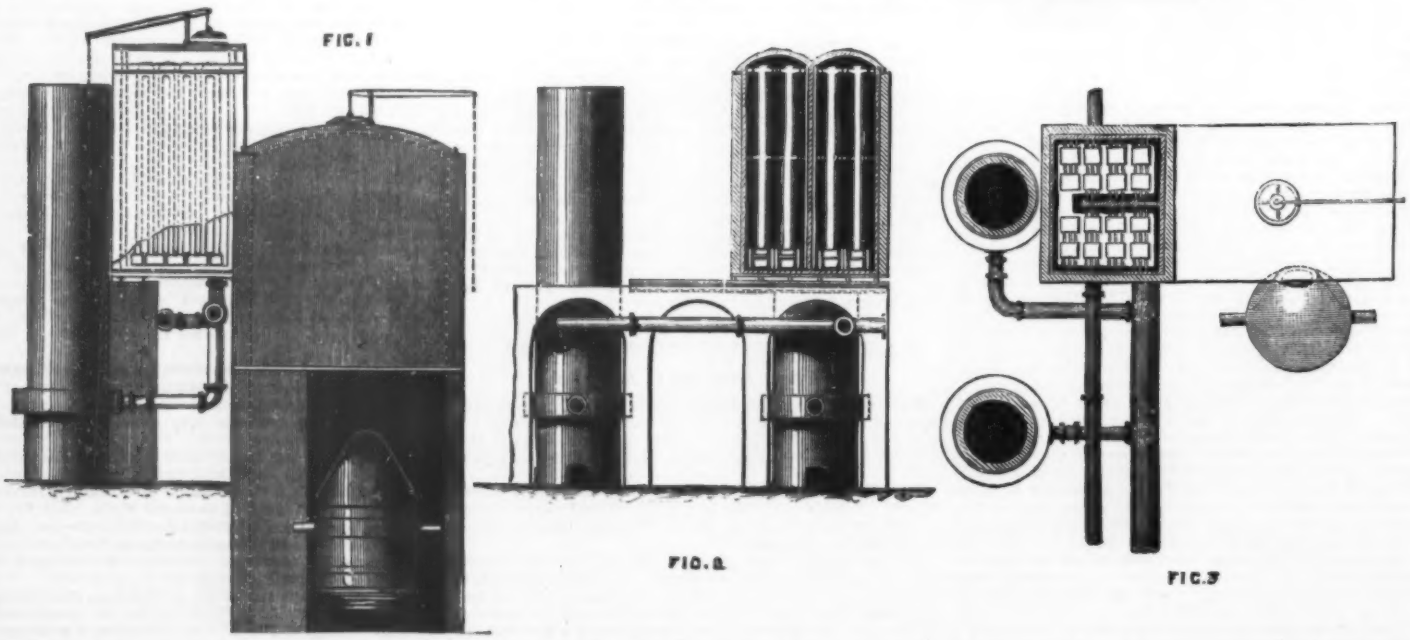
The cupolas for melting spiegeleisen are of similar construction, but proportionately smaller.

The converters, placed in the usual English position with respect to the pit (*i.e.*, they turn down toward each other), have a diameter of 8 feet 4 at the trunnions inside the casing, or 6 feet to inside the lining, the thickness of which is 9 inches. They are tipped by vertical hydraulic cylinders placed in the masonry below, the trunnions of such a length as will allow the vessel to rotate nearly ⅞ of a revolution; by this means, at the end of each blow all the slag is effectually turned out, and the converter may be placed in almost any position for repairs. The pinions on the trunnion ends and the racks which gear into the pinions are of steel, the teeth being slotted out of the forged bar. The tuyere blocks are removable from the vessel bottoms, and consist of a bottom plate, 3 inches thick, containing 15 holes through which the tuyeres (each 22 inches long, pierced with 13⅜ holes) are placed; the space between is rammed up with gannister in the usual way; they are dried very gradually in stoves for about 80 hours, and when required to be used are lowered into the vessel bottom as hot as possible by means of an overhead crane, the vessel being placed in a vertical position bottom upward. After being secured by means of set screws, the vessel is turned round, and the annular space of from 2 to 3 inches round the block is filled up with "slurry," a liquid mixture of gannister and water. The operation of changing a block takes about half an hour, and they require about five hours to dry; but as they invariably run six or seven and often as many as eight or nine "blows," and as our rate of working has never exceeded fourteen "blows" in the twelve hours, the vessel with the new block is dry and ready for use by the time the other vessel requires a new one. The hot-blast stoves in connection with the converters are situated on the outside of the blowing stacks or chimneys, which usually carry the flame away from the converter mouth to the atmosphere. The arrangement is clearly delineated on the drawings.

* Paper read at the Annual Meeting of the Iron and Steel Institute, March 29th, 1878.

The flame or hot gases discharged from the converter mouth rise and become diffused in the blowing stack (covered over to prevent their escape upward), and enter the first of the two chambers of the stove through a doorway in the side of the stack, the passage of the hot gases being regulated by two dampers, one placed on the top of the





MANUFACTURE OF BESSEMER STEEL AND STEEL RAILS.

second chamber at the end nearest the stack, and the other on the top of the blowing stack itself. The pipes are sixteen in number (eight in each chamber), and 16 feet long, of the ordinary U pattern, and give a heating surface of 1,712 square feet. Stoves of a similar description are attached to each of the four converters, and the valves, pipes, and mains are arranged in such a way that the cold blast can be passed through either one or other of the stoves on its way from the blast-engine to the cupolas.

The ingot pit is semi-circular, of 17 feet 6 inches radius, and 4 feet deep. The ladle-lift, which is moved round by hand-power, has a lift of 6 feet. The ladles (four in number) are lined with gannister of the same composition as that used for the vessels. The ingots for rails are 11¼ ins. square, and for the most part are cast upward in groups of sixteen. The bottom on which the moulds are placed consists of a slab or plate of cast iron, 13 feet long and 3 feet wide, formed to suit the curve of the pit, with a recess 6 inches square and 3 inches deep in the middle for a center brick (over which the guit is secured), and from which on each side main channels, containing firebrick runners, run lengthways to within 6 inches of each end of the bottom, communicating with sixteen branches, the hole in the end of each branch looking upward, over which hole the moulds are placed, forming a double row of four on each side of the center-piece and guit. There are two such groups in each pit, one under each crane, and the ingots are cast in them alternately. The two 5-ton ingot cranes, having a lift of 8 feet and jibs 20 feet long, are placed on each side of the pit in such a position that half of its edge is swept by each of them. The two 1-ton loading cranes are placed on the wall, one in front of each of the 5-ton cranes, arranged in such a way that they can pick up ingots, etc., deposited by the two former. They have a lift of 6 feet, and the jibs are 12 feet long. The ram-tops are supported by overhead bearings attached to the wall, to which they themselves are secured; by this means the bottom gland used in the 5-ton cranes (where there is no overhead bearing) is dispensed with. I should strongly recommend those people who are inclined to convert their ironworks into steelworks to adopt the American plan of three cranes, instead of two, for the pits, so as to enable them to clear the pits sooner than we can.

The blast for all the cupolas is supplied by a single-cylinder horizontal blowing engine, with a steam-cylinder of 36 inches diameter, an air-cylinder of 80 inches diameter, and a stroke of 7 feet.

The blowing engines are vertical, and were constructed by Messrs. W. & J. Galloway & Sons, Manchester. They have a pair of steam-cylinders of 40 inches diameter, a pair of blast-cylinders 54 inches diameter, and a stroke of 5 feet.

The hydraulic pressure for the Bessemer machinery is produced by a large horizontal pumping engine, made by Messrs. Walker, Eaton & Co., having a steam-cylinder of 46 inches diameter and a stroke of 8 feet. The pumps are placed one at each end of the large steam-cylinder, and the diameter of the piston rod, the ends of which form the plungers for the pumps, is 9 inches. The steam valve for the large cylinder is moved by a smaller steam-cylinder, the valve of which is actuated by a "tappet" or double ended lever, deriving its motion from a roller fixed in a cross-head on the end of a small rod attached to the piston of the large cylinder. A smaller pumping engine, of the same type, with 5-inch rams and 4-feet stroke, and a pair of donkey pumps, by Messrs. Galloway, of Manchester, act as auxiliaries, and with two accumulators, one with a ram 24 inches diameter and a lift of 14 feet, the other with a ram 18 inches diameter and a lift of 10 feet, weighted to give a pressure of 450 lbs. per square inch, comprise the hydraulic power of the plant.

The mode of working is as follows: One cupola for melting pig iron is used at a time; this is filled up with cokes to the level of the tuyeres, and the charging is then conducted in the following proportions: First fifteen pigs, then three baskets of coke (from 1½ to 3 cwt.), then another layer of fifteen pigs, and three more baskets of coke, and so on until the cupola has received three entire heats, or 24 tons, after which the charges are increased to twenty-five pigs and three baskets of coke alternately, and this proportion is maintained until the cupola is blown out, a sufficient quantity of limestone being added with each charge to give a fluid slag. The blast is heated to a temperature of from 400° to 500° Fah. with the waste heat from the converters in the stoves already described. To gauge the size of the heats, slag holes are used, placed at such a height from the bottom of the cupola that the well just holds the requisite charge. From this hole the slag is drawn off, and, as soon as the metal appears, the "heat" is tapped out into the converter, and after being blown, and the spiegeleisen added in the usual way, it is poured into the ladle, and cast into ingots in the group. The 5-ton cranes are used for clearing the pit of all rubbish, for adjusting the ingot moulds on the bottoms, for removing the same after casting, and for lifting the ingots out of the pit, two at a time, and placing them within reach of the 1-ton cranes, by which they are loaded singly, while still red hot, on hand bogies for charging direct into the rail-mill furnaces.

Since we have used hot blast exclusively (*i. e.*, from the commencement of the present year) in melting our pig iron the average quantity of coke consumed per ton of pig iron charged has been under 1 cwt. 1 qr. 15 lbs. During the week ending 23d February, in one pit 1,079½ tons of pig iron were melted with 70 tons of coke, 1 cwt. 1 qr. 5¼ lbs. per ton of pig-iron charged; and during the week ending 16th March, in two pits, 2,187 tons of pig iron were melted with 144 tons of coke, or 1 cwt. 1 qr. 7½ lbs. per ton of pig charged. These figures include all coke used in getting up cupolas.

With respect to the time required to bring the charge down, a heat of 8 tons has been melted frequently in half an hour, but as this is very much quicker than is necessary for our requirements in the pit, we prefer to work the cupolas slower. In our usual practice, the time occupied in melting, from the making up of the tapping hole until the metal appears at the slag hole, is about forty minutes. The cupolas will melt from 600 to 800 tons before the lining gives way, so that two are required each week; the second one, however, is often patched, and serves for half of the week succeeding. The converters usually run from 2,500 to 3,000 heats per pair without re-lining; as many as 1,800 have been blown from one lining. The ladles require lining after every twenty-five heats.

In one pit, from one pair of converters, the largest single turn's work has been 108 tons 14 cwt.
The largest week's work, 1,023 tons 6 cwt.
In both pits, from two pairs of converters, the largest week's work has been 2,020 tons 9 cwt. 1 qr.

The form of bottom for casting ingots, and the arrangement described, has now been in use at these works for nearly three years, and the results therefrom have been very satisfactory in every respect.

ON THE MANUFACTURE OF STEEL RAILS.

The rail-mill plant consists of the ordinary heating furnaces, a three-high roughing train, and a two-high reversing finishing train; the centers of rolls are 24¼ inches apart. The roughing train is driven by a large horizontal engine, having a pair of steam-cylinders, each 36 inches diameter and 48 inches stroke, and a fly-wheel 25 feet diameter and weighing about 30 tons. It is connected to the pinions by means of a pair of steel couplings, or "crabs," the fast one, or the one keyed on to the shaft of the engine, being secured to the loose one, or the one that receives the spindle end, by eight 2½-inch turned bolts. The spindle and box between engine and pinions are also of steel. The pinions are of steel, having a width of tooth of 24 inches and a pitch of 6 inches. The spindles between the pinions and the rolls are of steel, and the boxes of cast iron. The middle roll, made of steel, always runs in the same line as center of engine shaft, and the top and bottom rolls (the former of cast iron, and the latter of steel) are adjustable to it. The housings are of cast iron, but the chocks, guides, guards, and cramp bars are of steel; the brasses are deep-sided, so that side chocks are dispensed with. The roughing rolls are 7 feet long in the body, and are arranged for ten passes in such a way that one set of rolls will suit all sections of rails; they are never changed except when they require reducing or trimming up, or in case of breakage. In front of the rolls is a revolving roller drawn by means of friction gearing, and under the control of one of the men, by whom the ingots are carried into the bottom grooves. Behind the rolls is a table 24 feet long and 10 feet wide, supported at the back, on the same level as top of the middle roll, by a pair of links; a second pair of lines attach the front end of the table to the housings, in such a way that the table, in lifting, is drawn forward to the rolls radially from the fixed centers of these links, and for the first three or four passes the ingot is actually thrown into the top grooves without any assistance from the workman. The lifting is effected by a 10-inch steam-cylinder bolted to the sides of one of the housings, transmitting its power to the front end of the table through levers on a rocking shaft. The finishing train placed at the end of the roughing train, at a distance of about 2 feet from it, is driven by a pair of Ramsbottom's reversing engines, made by Messrs. Galloway & Sons, which have a pair of steam-cylinders, each 36 inches diameter and 54 inches stroke; the power is transmitted from the engine shaft to the shaft which drives the rolls by steel gearing having teeth of 6 inches pitch and 21 inches wide; the wheels are arranged as 1 to 2½. The couplings or crabs, boxes, and spindles are exact duplicates of those used in the roughing train. The finishing rolls are 4 feet 6 inches long, and are arranged for five passes, the working position of these holes being 1 foot above the floor line. Loose rollers running on the mill floor are used on both sides of the train for carrying the rails backward and forward to it, and a series of fixed rollers, placed about 10 feet apart, driven by power, carry the finished rolled rail down to the saw under the loose rollers. The hot saw, 3 feet 6 inches in diameter, making 700 revolutions per minute, is placed at a distance of 66 feet from the rolls, but as the cutting level is on the mill floor, and the rolling level a foot above this, the rolling and sawing are carried on simultaneously. There are two hot banks, one on each side of the saw, which are filled alternately; by this means the rails are well hot-straightened before they are taken to the machines. The straightening, punching, and snipping machines are by De Bergue & Co., Tannett, Walker & Co., and Buckton & Co., of their usual types; and these, with a cold saw and rail-ending machine by the latter makers, and six drilling machines by Buck & Son, of Bolton, each arranged for drilling two holes at once, complete our rail-making plant.

The mode of working is as follows: The ingots loaded on the mill bogies in the Bessemer shops, red hot, are transferred as quickly as possible to the rail-mill furnaces, and, after being heated, are rolled off direct into rails, the number of lengths varying according to the length of rail required. Our usual practice is three lengths for 20-feet rails and under, and two lengths for all above, up to 30 feet. The furnaces will take seven ingots in a charge, and turn out five charges per turn. The rails, after being rolled, are carried down from the rollers on the rollers described, straightened as far as possible on the hot bank, and afterward finished in the usual manner.

Our output from the mill varies according to the lineal weight of rail.

The largest single turn's work (10½ hours) has been 196 tons 11 cwt. 1·20 qr.
The largest double turn's work (21 hours) has been 386 tons 14 cwt. 2·25 qrs.
The largest week's work, 1,571 tons 5 cwt. 2·0 qrs.
Of these 588½ tons were flanged 66½ lbs. per yard.
270½ " " 64 " "
712½ " bull-headed 80 lbs. per yard.

And during this week the finishing rolls were changed four times. The number of rails rolled was 6,154. The total number of hours worked was 105, but as 6 hours were occupied in changing rolls, the mills were only running 99 hours. The rate of rolling, therefore, was as follows: 586 rails per turn of 10 hours, or 62 rails per hour, or 214 rails more than 1 rail in every minute that the machinery was in motion.

I now beg to say that what we may claim is that we have succeeded in making bottom castings a success. The advantages of this plan are that the ingot moulds will last considerably longer than by the process of casting from the top, and that the weights arrived at, for each ingot, are nearer to the weight of the rail required, thereby effecting a saving in the cross ends.

We may also congratulate ourselves on the process employed of beating the blast, which saves us at least 2 cwt. of coke per ton. Diagrams of this I have laid before you.

With regard to our employing a three-high mill for roughing and cogging, and a reverse mill for finishing, I consider that it gives the following advantages, viz., that we take the ingot direct, and rough and cog it in one mill, which mill is so adapted that it will suit any section of rail, and is so placed that the cogged bloom can be passed over to the finishing mill without being reheated. If you employ a reverse mill for roughing and cogging, there must be a loss of time and of steam. For example, take an ingot of 4 feet 6 to 5 feet long, weighing 13 to 14 cwt.; by employing a reverse mill for cogging, of 3 feet diameter, one half-turn of the rolls should accomplish the labor; but making every allowance, one turn, at all events, of the rolls should suffice to bring it down to the requisite length for the next hole. This by a three-high mill is obviated, and the amount of power used is not greater than is required. The disadvantage of a reverse mill of course disappears when the bloom is turned out of the cogging mill a considerable length.

THE HUELVA PIER OF THE RIO TINTO RAILWAY.

AT the meeting of the Institution of Civil Engineers on the 2d of April, the paper read was on "The Huelva Pier of the Rio Tinto Railway," by Mr. T. Gibson, Assoc. Inst. C. E. The cupriferous iron pyrite mines of Rio Tinto, in the South of Spain, were very ancient, having been worked by the Romans. Their output last year amounted to 750,000 tons. The mines were situated about 50 miles from the Port of Huelva, which port was about twelve miles from the bar of the River Odiel. There being no accommodation at the port for shipping, the traffic was formerly conveyed between the vessels and the beach by barges and small craft, a mode of shipment manifestly only suited for a small trade. The important question was whether the roadway of the pier should be at a comparatively small height above high water and the wagons be lifted by hydraulic or some other power to an elevation sufficient to admit of the contents being tipped into the hold of the vessel, or whether this pier should be built upon a rising gradient, so that trains of wagons could be pushed up by a locomotive to the height necessary for the shipment of the ore to be effected by gravitation. Having regard to the large amount of material to be shipped and to the advisability of being able to do this quickly, it was decided to adopt the latter plan, though it involved a more costly structure. The total length of the pier and of the approach from the station yard was 2,444 feet. The screw pile portion was 1,900 feet long. The distance was made up of twenty-nine spans of 50 feet each, and thirty groups of cast-iron screw piles and columns, eight in each group, placed fifteen feet apart from center to center. The pier-head, alongside which the ships were moored, was protected by the shipping deck wharf. This wharf was independent of the cast-iron piling, and was composed of creosoted red wood Memel fenders, supported by creosoted Memel piles, cross bearers, transoms, and longitudinal walings. The principal difficulty was the want of solidity of the foundation, which proved to be worse than was at first anticipated. With two series of lines, one above the other, a greater load had to be borne than if the pier had simply to carry the work of the mines. It was found that the screw piles alone would not give sufficient area of base unless considerable expense was incurred in construction. It was therefore decided to provide additional bearing surface by the introduction of timber platforms, fastened to the piles by cast-iron disks, which clamped the respective piles below a collar cast specially on the pile shaft, so as to rest upon the disk. In this way the load on the pier was transmitted through the columns, piles and disks to the platforms, which rested on the bed of the river.

THE UNDERGROUND RAILWAY IN PARIS.

A PLAN for the construction of underground railways in Paris has been approved by the Council-General of Ponts-et-Chaussées and the Minister of Public Works. If the scheme is carried out a subvention of 106,000,000 francs would be furnished by the State, the Department of the Seine, and the city of Paris. The central terminus would be in the garden of the Palais Royal, at a depth of about 24 ft., and from that point three main lines would branch off—one by the Bourse, Opéra, St. Lazare station, and Batignolles; another by the central markets to the Eastern and Northern Railway, with branches at the Boulevard Sebastopol to the Lyons, Vincennes, and Orleans termini; the third to the Place St. Germain-des-Près, Montparnasse, and Sceaux railway stations. Besides these principal lines, a subsidiary one would run on the south bank of the river from the Orleans station to the Quai-d'Orsay at Grenelle, passing by the Halle-aux-Vins, Polytechnic School, and Place St. Germain-des-Près.

NEW SUBWAY IN LONDON.

A NEW subway connecting the termini of the London, Chatham, and Dover, and the London, Brighton, and South Coast Railways at Victoria with the underground station of the Metropolitan District Railway is in course of construction. The passage across the open yard lying between the two stations being always much crowded with omnibuses and other vehicles has been a source of danger and annoyance to passengers, and the subterranean way is being built at the joint expense of the three companies. It will start from the booking-office of the District Railway, which is below the level of the street, to the point where the Chatham and Dover and the Brighton Railway stations join; access to it from here will be by steps leading right and left, thus affording great convenience to passengers by those lines.

INCREASE OF MAIL SERVICE IN THE SOUTH.

SPEECH of Hon. Robert B. Vance, of North Carolina, in the House of Representatives, April 20, 1878, on the bill (H. R. No. 4246) making appropriations for the service of the Post Office Department for the fiscal year ending June 30, 1879, and for other purposes; and the amendment of Mr. Vance as follows:

Provided, That the Postmaster-General shall secure the delivery of the mails between Washington City and New Orleans at a rate of speed not less than twenty-five miles an hour.

MR. BLOUNT, of Georgia, made a point of order that the legislation was new, and not in the line of economy; which point the chairman of the Committee of the Whole sustained and ruled the amendment out of order.

MR. VANCE. Mr. Chairman: I desire to call the attention of the committee and the country to the fact that the mail facilities furnished the States of Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, Tennessee, Arkansas, Mississippi, and Texas are far inferior to those of other sections, particularly in the rapid delivery of the mails. I gleaned the following facts from officials at the Post Office Department: Average speed per mile from New York to Washington, thirty-three miles per hour; from New York to Chicago, via New York Central, twenty-eight miles; from Washington City to Chicago, via Baltimore and Potomac line, twenty-eight miles; from Washington to New Orleans, via Richmond, Atlanta, etc., twenty-two miles.

Thus it will be seen that from Washington south the rate is 50 per cent. slower. A delivery of twenty-five miles an hour would put the mails into New Orleans five and one-fourth hours earlier, and twenty-six miles would save seven and one-fourth hours, conferring corresponding favors on the intermediate points.

SOUTHERN PRODUCTIONS.

I take the ground that it is the duty and interest of the Government to revive the business and industries of the great South. The extreme Southern States have been pro-

ducers of the raw material by which the looms and spindles of the great North have been kept at work. The South has been a purchaser which has enriched the manufacturer of the North. Shoes, hats, leather, woolen cloth, cotton cloth, and a thousand and one articles manufactured at the North have found ready purchasers in the farming and planting population of the South.

Here is a magnificent country with twelve million people, a coast line of nearly three thousand miles on the Atlantic and Gulf, 15,201 miles of finished railroads, and a grand stretch of 751,098 square miles of territory, reaching out its hands to the Government for protection and development.

Let us look at some of the products of the South: There were grown in 1876—wheat, 21,844,490 bushels; Indian corn, 178,081,426 bushels; rice, 73,635,021 pounds.

COTTON.

But cotton has been the great crop of the South. The product of 1876 was 4,669,288 bales, of four hundred and forty pounds each, making the grand aggregate of 2,054,486,720 pounds.

To get an idea of the value of the cotton crop to this country, glance for a moment at the figures:

Exports from the United States, 1876, cotton and manufactures of (valuation):

Sea Island	$941,803
Other, unmanufactured	191,717,459
Colored manufactures	1,455,462
Uncolored manufactures	5,314,738
All other manufactures of	952,778
Total valuation	$200,382,240

Where does England buy her cotton? The statistics show that in 1876 Great Britain imported 1,487,858,848 pounds of cotton, of which in round numbers one thousand million pounds were furnished by the South.

Gentlemen will see at once what an immense benefit is conferred upon the United States by the cotton crop in bringing money from abroad, as the cotton imports into this country in 1876 amounted to $22,725,598.

TOBACCO.

But the South has added to the material wealth of the country from other sources. The Southern States alone produced in 1870, 71,066,596 pounds of leaf tobacco, which found its way, when manufactured and in leaf, into the markets of the world, making, at ten cents per pound, the sum of $7,106,659 60. But much of this tobacco, produced in Virginia and North Carolina—"the gold-leaf Orinoco," "the silky Pryor," etc.—ranged at prices much higher than the foregoing. The average sales of one crop in Lynchburgh, from Madison County, North Carolina, was $69 per one hundred pounds.

THE PRECIOUS METALS.

The States of Alabama, Georgia, North Carolina, South Carolina, Tennessee, and Virginia have furnished to the mints and assay offices as follows:

Gold	$21,142,105 78
Silver	45,150 09

The collection of gold in the North Carolina gold-belt, covering the counties of Randolph, Mecklenburgh, Cabarras, Lincoln, Burke, Rutherford, McDowell, Cherokee, etc., is decidedly on the increase. The successful reopening of the mint for coinage of gold at Charlotte, North Carolina, will greatly add to the quantity of this beautiful and valuable metal.

Add to the gold the deposits of coal, iron, copper, mica, asbestos, agalmatolite, marble, corundum, etc., and you can form a notion of the vast mineral wealth of the regions named.

The iron ores of Western North Carolina are not surpassed in the world. The red hematite and magnetic ores abound profusely. A test of the North Carolina iron, made at the Washington Navy-yard some years since, proved its superiority to the Swede. The Government should procure this iron for repairing our navy.

NORTH CAROLINA GRAPES AND APPLES

are also of varied and splendid quality. Large fortunes have been made in the low countries by raising peaches for the early markets. The middle and mountain sections are celebrated for apples, pears, grapes, etc. The Scuppernong and Catawba grapes are natives of North Carolina. I have seen the statement that one Scuppernong vine in Eastern North Carolina covered four acres of land.

The table-lands of the Blue Ridge, in Virginia and North Carolina, produce the apple in size and quality not to be overdone anywhere, especially this being true of Western North Carolina. Apples have been grown in the counties east and west of the Blue Ridge from Virginia to Georgia ranging in weight from sixteen to thirty-two ounces each, and the flavor superb. The whole country saw with surprise the display of North Carolina apples at the Centennial Exhibition.

A FIELD FOR EMIGRATION.

What a field this is, Mr. Chairman, for the emigrant to settle in. If he wishes timber for manufacturing we have it in abundance—the oak, the pine, the cypress, the hickory, the poplar, the black walnut, the curled maple, the locust, and the wild cherry. But recently an order was sent to Western North Carolina for a vast quantity of locust pins to be used in building ships in the German Empire. In all this beautiful land of the sun the real settler is everywhere received with cordiality, regardless of politics or of creeds.

A fast mail service, affording rapid communication with the world, will have a tendency to increase the population in this sunny region, as well as the further development of its splendid resources.

HARBORS.

Another reason for increasing mail facilities are the ports of the South, among which may be mentioned Norfolk and Port Royal. The latter is said to be one of the finest on the Atlantic coast. In case of a foreign war rapid communication by rail with these great ports would be of immense advantage.

THE SOUTH AS A HEALTH RESORT.

Rapid communication and delivery of the mails southward would be a blessing to those who go there for restoration to health. By examining the maps accompanying the census report of 1870 it will be observed that Florida and Western North Carolina are points clearer of consumption than any others in the United States. This fact is to be accounted for on the one hand, Florida, by the exceeding mildness of its climate, and on the other, Western North Carolina, by the purity of its atmosphere and the height of its mountains.

NORTH CAROLINA MOUNTAINS.

By actual measurement, when building the North Carolina and Western North Carolina railroads from the ocean, the great dome of the Black Mountain, in the Alleghany Range, was found to be sixty-seven hundred and eleven feet above tide-water.

It is contemplated at an early day to re-establish a signal station on the mountain, to give notice of storms striking Cape Hatteras.

The interests of twelve millions of people demand increased mail facilities at the hands of the Government. The children in these States need to be educated. The fast-mail service is an educator. It gives the people daily news from the world. Pius IX. died about four o'clock and thirty minutes P.M. At six o'clock P.M. I read the news in the *Evening Star*. At ten o'clock A.M. next day it was received at Saulsbury, North Carolina. Especially does the fast-mail service aid the "star service," the people's line of mails in the interior. By rapidly depositing the mails at intermediate points the horse and stage mails get that much sooner to the people.

A fast train passing through a country and a rapid delivery of the mail increases the energy and stirs the activity of the people. The growth of our population demands more rapid movements along the lines of trade. Because we rejoice in "the dollar of the daddy" is no reason why we should still go to mill with corn in one end of the sack and a rock in the other. Let us have grain in both ends of the sack. It no longer takes three months to cross the Atlantic nor three years to circumnavigate the globe. The spirit of progress and invention has brought into existence a thousand wonderful and beautiful things. They speak to our hearts evermore, and cry out "forward" in the grand work of elevating humanity; and the fame of Maury shall roll with the mysterious currents of the ocean, the name of Morse be sounded along the track of the steed of fire—the telegraph—while the voice of Edison will speak from the phonograph when they all have passed away.

MUSICAL SAND.

A SHORT time since Mr. W. R. Frink sent from the Island of Hawaii, of the Hawaiian group, to the California Academy of Sciences, a bottle of sand which possesses some peculiar qualities. A sand drift exists there some sixty feet high, and by taking two handfuls of this sand and slapping it together a sound is produced like the low hooting of an owl—more or less sharp as the motion is quick or slow. At the time of the receipt of this sand we gave a description of its peculiarities as detailed in a letter accompanying the gift:

"The bank, which is composed of this sand, commences at a perpendicular bluff at the southwest end of the island, and extends one and a half mile almost due south, parallel with the beach, which is about one hundred yards distant from the base of the sand bank. This sand drift is about sixty feet high, and at the extreme south end the angle preserved is as steep as the nature of the sand will permit. The bank is constantly extending to the south. It is said by the natives that at the bluff and along the middle of the bank the sand is not sonorous. Sit down upon the sand and give one hand a quick circular motion, and the sound is like the heavy base of a melodeon. Kneel upon the steep incline, extend the two hands and clasp as much sand as possible, slide rapidly down, carrying as much sand as possible, and the sound accumulates as you descend, until it is like distant thunder. In this experiment the sound was sufficient to frighten our horses, fastened a short distance from the base of the drift.

"But the greatest sound we produced was by having one native lie upon his belly and another taking him by the feet and dragging him rapidly down the incline, carrying as much sand as possible with them. With this experiment the sound was terrific, and could have been heard many hundred yards distant. With all the experiments that were made, it seemed the sound was in proportion to the amount of sand put in motion with a proportionate velocity. Another consideration seems requisite, that is, its perfect dryness.

The dry sand would sound on the surface, where six inches beneath it was wet; but if any of the wet sand became mingled with the dry, its property of sounding ceased at once. The sand appears to the eye like ordinary beach sand, but ordinary beach sand will not produce the sounds. It has been said that it lost its sonorous properties when taken away from the bank. But I can discover no diminishing of its sonorous qualities, even with the bottle uncorked, and we have had rain frequently, and an atmosphere more than ordinarily moist for this time of year. Perhaps if exposed to a very damp atmosphere it might absorb moisture enough to prevent its sounding."

In order to ascertain, if possible, the cause of the sound produced by this sand, Dr. James Blake has investigated its structure under the microscope, and at the last meeting of the Academy of Sciences he stated that the facts he had ascertained fully explain the manner in which the sound is emitted. As the grains of sand, though small, are quite opaque, it was necessary to prepare them so that they should be sufficiently transparent to render their structure visible. This was done by fastening them to a glass slide and grinding down until one surface was obtained. This surface was then attached to another slide, and the original slide being removed the sand was again ground down until sufficiently transparent. The grains were found to be chiefly composed of small portions of coral and apparently calcareous sponges, and presented under the microscope a most interesting object. They were all more or less perforated with small holes, in some instances forming tubes, but mostly terminating in blind cavities which were frequently enlarged in the interior of the grains, communicating with the surface by a small opening. Several specimens of what appeared to be minute bivalve shells were also met with. Besides the elements derived evidently from living beings, these sands contained small, black particles which the microscope showed to be formed principally of crystals of augite, nepheline and magnetic oxide of iron, imbedded in a glossy matrix. These were undoubtedly volcanic sand.

It would be impossible to give more than a general idea of the appearance of this sand under the microscope, except with elaborate drawings. The structure of the grains, Dr. Blake thinks, fully explains the reason why sound is emitted when they are set in motion. The friction against each other causes vibration in their substance, and consequently in the sides of the cavities they contain, and these vibrations being communicated to the air in the cavities, under the most favorable conditions for producing sound, the result is the loud noise which is caused when any large mass of sand is set in motion. There are in fact millions upon millions of resonant cavities, each giving out a sound, which may well swell up to resemble a peal of thunder, with which it has been compared, and the comparison, Dr. Blake knows from those who have heard it, is not exaggerated. The effect of rain or dampness in preventing this sound is owing to the cavities in the sand becoming filled with water and thus rendered incapable of originating vibrations. The chemical composition of the sand, with the exception of the volcanic grains, is calcareous, being completely dissolved by chlorohydric acid, although it is probable that some of the spiculæ in the sponges are siliceous.—*Naturalist's Bulletin.*

"GASPILLAGE ET INSOUCIANCE."

"WASTEFULNESS and carelessness"—these are the words with which an eminent French engineer sums up, as it were, his estimate of our metallurgical arts, and of English industry in general. He allows that we have many good points—industry, energy, enterprise, and invention—but the two faults above named he considers are a most serious drawback, and give a great advantage to our rivals. Wastefulness shows itself as plainly in our domestic life as in our manufacturing operations. A Frenchwoman will make relishing, wholesome, and nutritious dishes from what an English "plain cook" will throw to the dogs or consign to the swill-tub. A French manufacturer will produce pleasing and salable articles from raw materials which in England nobody will condescend to bother with. The fact is, we rather admire waste, and think that there is something essentially noble and high-spirited about it. We think it mean to insist upon utilizing any article to its full extent. Alas! any fool can waste, but no fool can be really and wisely economical. If he attempts to save materials he wastes time and labor. The fact, then, that the French succeed so well in utilizing all residues and by-products, and in obtaining from every material its utmost duty, is no small tribute to their clear-headedness and ingenuity.

Carelessness—the second item in our national indictment—is equally undeniable. We possessed at one time a most indisputable superiority in the useful arts. From 1820 to 1840 manufactures, in the modern sense, scarcely existed on the Continent. The steam engine had not yet found there a home. Dyeing, tanning, etc., were carried on as trades rather than as manufactures. Now, the superiority which we then enjoyed was due to a variety of causes, some of them, in the ordinary sense of the word, accidental. Our country had for centuries been free from the scourge of foreign invasion. Property was secure, and capital had accumulated. Our stores of coal, if not larger than those of all other countries, had been earlier discovered and brought into use. But in spite of all these natural advantages, and of others that might be mentioned, we are apt to attribute our recent industrial pre-eminence exclusively to our personal and national qualities, and to fancy that we could at any time win it back if required. As a nation, we are not inclined to prepare for a distant future by quiet, steady preparation, at once unhasting and unresting. We trust to our pluck and our luck, and, Micawber-like, hope that "something will turn up." It is well known that Prussia, after the fatal battles of Jena and Auerstedt, when in the very depths of disgrace, set to work at those military preparations which, steadily pursued for nearly sixty years, bore their full fruit at Sedan and Metz and Paris. But it is not so well known that from the very same date she began civil preparations which may perhaps win for her a pre-eminence in the arts not less signal than she has acquired in the battle-field. Unwilling to tolerate the military superiority of France, she passed her whole male population through the army. But she has been equally unwilling to tolerate the commercial and manufacturing superiority of England, and, in order to contest our position, she has striven to render her whole population thoughtful and intelligent.

For a long time we looked on and laughed at the "unpractical dreams," the "misty theories," of our neighbors across the North Sea. But at last it dawned upon us, in the very unpleasant shape of tables of exports and imports, that these theorists were, after all, getting command of certain branches of trade which we flattered ourselves should have been our own in perpetuity. The coal-tar colors were first invented in England; the raw material is more abundant with us than in any other country, yet Germany can supply us with these dyes, actually buying of us crude products such as anthracene, and selling us back the finished colors. Nay, to make the matter still more plain, in all the chief English establishments for the manufacture of such dyes the chief positions are, as a rule, occupied by Germans. Partly aroused from our slumbers by this and other kindred facts, we concluded that it was necessary for something to be done. So, after wasting much precious time in speech-making—another of our national vices—we did—what? Did we establish polytechnic schools like that of Aix-la-Chapelle, where, for about £14 annually, a thorough and practical knowledge of chemistry, geology, physics, etc., can be obtained? No, we opened board-schools! These establishments may doubtless have their value in other directions, but if intended as a step toward maintaining and improving our industrial position, they were simply ridiculous. We want more inventors and discoverers, not more men who can just read and write. We want not so much to force elementary knowledge upon those who do not care for it as to place higher knowledge within the reach of those who crave for it. Some few and scattered attempts are now being made to supply such knowledge, if they do not come too late.

Another proof of our national carelessness is shown in our treatment of inventors. In good times we are, in our own opinion, doing well enough, and even if we see convincing proof that by adopting a new process we might do better, we do not like to move till compelled by the action of competitors. We know of an instance where a wealthy firm admitted that the adoption of the Gibb's drying machine to a certain residual product would put some £15,000 annually into their hands. But they did not care to "bother;" they were wealthy, could afford to waste!—*Chemical Review.*

AN ARTESIAN WELL 3,120 FEET DEEP.

AT the city of Pesth an artesian well has been dug of the depth of 3,120 feet, and supplies water of the temperature of 161° Fahr. It may yet be possible to warm our houses, workshops, etc., fill our steam boilers, and supply our manufactures with natural hot water, thus effecting a vast economy of coal.

THE PHONOGRAPH AND ITS FUTURE.

By THOMAS A. EDISON.

OF all the writer's inventions, none has commanded such profound and earnest attention throughout the civilized world as has the phonograph. This fact he attributes largely to that peculiarity of the invention which brings its possibilities within range of the speculative imaginations of all thinking people, as well as to the almost universal applicability of the foundation principle, namely, the gathering up and retaining of sounds hitherto fugitive, and their reproduction at will.

From the very abundance of conjectural and prophetic opinions which have been disseminated by the press, the public is liable to become confused, and less accurately informed as to the immediate result and effects of the phonograph than if the invention had been one confined to certain specific applications, and therefore of less interest to the masses. The writer has no fault to find with this condition of the discussion of the merits and possibilities of his invention; for, indeed, the possibilities are so illimitable and the probabilities so numerous that he—though subject to the influence of familiar contact—is himself in a somewhat chaotic condition of mind as to where to draw the dividing line. In point of fact, such line cannot with safety be defined in ordinary inventions at so early a stage of their development. In the case of an invention of the nature and scope of the phonograph, it is practically impossible to indicate it to-day, for to-morrow a trifle may extend it almost indefinitely.

There are, however, certain stages in the developing process which have thus far been actually reached; certain others which are clearly within reach; and others which, though they are in the light of to-day classed as possibilities, may to-morrow become probable, and a little later actual achievements. It is the intention of the writer in this article to confine himself to the actual and the probable, to the end that a clearer conception of the immediate realizations of the phonograph may be had. He concedes to the public press and the world of science the imaginative work of pointing out and commenting upon the possible. It is in view of the liberal manner in which this has already been done, and the handsome treatment he has received at their hands, that he for the first time appears *in propria persona* to discuss and comment upon the merits of one of his own inventions.

In order to furnish a basis upon which the reader may take his stand, and accept or combat the logic of the writer in his presentment of the probabilities of the phonograph, a few categorical questions are put and answers given upon the essential features of the principle involved:

1. Is a vibrating plate or disk capable of receiving a complex motion which shall correctly represent the peculiar property of each and all the multifarious vocal and other sound-waves?

The telephone answers affirmatively.

2. Can such complex movement be transmitted from such plate, by means of a single embossing-point attached thereto, to effect a record upon a plastic material by indentation, with such fidelity as to give to such indentations the same varied and complex form; and, if so, will this embossing-point, upon being passed over the record thus made, follow it with such fidelity as to retransmit to the disk the same variety of movement, and thus effect a restoration or reproduction of the vocal or other sound-waves, without loss of any property essential to producing upon the ear the same sensation as if coming direct from the original source?

The answer to this may be summed up in a statement of the fact that, by the application of power for uniformity of movement, and by attention to many seemingly unimportant and minor details, such as the *form* and material of the embossing-point, the proper *dampening* of the plate, the character of the material embossed, the formation of the mouth-piece over the plate, etc., the writer has at various times during the past weeks reproduced these waves with such degree of accuracy in each and every detail as to enable his assistants to read, without the loss of a word, one or more columns of a newspaper article unfamiliar to them, and which were spoken into the apparatus when they were not present. The only perceptible loss was found to be in the quality of the utterance—a non-essential in the practical application of the apparatus. Indeed, the articulation of some individuals has been very perceptibly improved by passage through the phonograph, the original utterance being mutilated by imperfection of lip and mouth formation, and these mutilations eliminated or corrected by the mechanism of the phonograph.

3. Can a record be removed from the apparatus upon which it was made, and replaced upon a second without mutilation or loss of effective power to vibrate the second plate?

This is a mere mechanical detail, presenting no greater obstacle than having proper regard for the perfect interchangeableness of the various working parts of the apparatus—not so nice a problem as the manufacture of the American watch.

4. What as to facility of placing and removing the record-sheet, and as to its transportation by mail?

But ten or fifteen seconds suffice for such placing or removal. A special envelope will probably be required for the present, the weight and form of which, however, will but slightly increase the cost of postage.

5. What as to durability?

Repeated experiments have proved that the indentations possess wonderful enduring power, even when the reproduction has been effected by the comparatively rigid plate used for their production. It is proposed, however, to use a more flexible plate for reproducing, which, with a perfectly smooth stone point—diamond or sapphire—will render the record capable of from 50 to 100 repetitions, enough for all practical purposes.

6. What as to duplication of a record and its permanence?

Many experiments have been made, with more or less success, in the effort to obtain electrotypes of a record. This work has been done by others, and, though the writer has not as yet seen it, he is reliably informed that, very recently, it has been successfully accomplished. He can certainly see no great practical obstacle in the way. This, of course, permits of an indefinite multiplication of a record, and its preservation for all time.

7. What are the requisite force of wave impinging upon the diaphragm and the proximity of the mouth to the diaphragm to effect a record?

These depend in a great measure upon the volume of sound desired in the reproduction. If the reproduction is to be made audible to an audience, considerable force is requisite in the original utterance; if for the individual ear, only the ordinary conversational tone (even a whisper has been reproduced). In both cases the original utterances are delivered directly in the mouth-piece of the instrument. An audible reproduction may, however, be had by speaking at the instrument from a distance of from two to three feet in a loud tone. The application of a flaring tube or funnel to collect the sound-waves and the construction of an especially delicate diaphragm and embossing-point, etc., are the simple means which suggest themselves to effect this. The writer has not as yet given this stage of the development much attention, but sees no practical difficulty in gathering up and retaining a sectional part of the sound-waves diffused about the original source, within a radius of, say, three feet (sufficiently removed not to be annoying to a speaker or a singer).

The foregoing presentment of the stage of development reached by the several essential features of the phonograph demonstrates the following as *faits accomplis*:

1. The captivity of all manner of sound-waves heretofore designated as "fugitive," and their permanent retention.

2. Their reproduction with all their original characteristics at will, without the presence or consent of the original source, and after the lapse of any period of time.

3. The transmission of such captive sounds through the ordinary channels of commercial intercourse and trade in material form, for purposes of communication or as merchantable goods.

4. Indefinite multiplication and preservation of such sounds, without regard to the existence or non-existence of the original source.

5. The captivation of sounds, with or without the knowledge or consent of the source of their origin.

The probable application of these properties of the phonograph to the various branches of commercial and scientific industry presently indicated will require the exercise of more or less mechanical ingenuity. Conceding that the apparatus is practically perfected in so far as the faithful reproduction of sound is concerned, many of the following applications will be made the moment the new form of apparatus, which the writer is now about completing, is finished. These, then, might be classed as actualities; but they so closely trench upon other applications which will immediately follow, that it is impossible to separate them: hence they are all enumerated under the head of probabilities, and each specially considered. Among the more important may be mentioned: Letter-writing and other forms of dictation, books, education, reader, music, family record; and such electrotype applications as books, musical boxes, toys clocks advertising and signaling apparatus, speeches, etc., etc.

Letter-writing.—The apparatus now being perfected in mechanical details will be the standard phonograph, and may be used for all purposes except such as require special form of matrix, such as toys, clocks, etc., for an indefinite repetition of the same thing. The main utility of the phonograph, however, being for the purpose of letter-writing and other forms of dictation, the design is made with a view to its utility for that purpose.

The general principles of construction are a flat plate or disk, with spiral groove on the face, operated by clock-work underneath the plate; the grooves are cut very closely together, so as to give a great total length to each inch of surface—close calculation gives as the capacity of each sheet of foil, upon which the record is had, in the neighborhood of 40,000 words. The sheets being but ten inches square, the cost is so trifling that but 100 words might be put upon a single sheet economically. Still, it is problematical whether a less number of grooves per inch might not be the better plan—it certainly would for letters—but it is desirable to have but one class of machine throughout the world; and as very extended communications, if put upon one sheet, could be transported more economically than upon two, it is important that each sheet be given as great capacity as possible. The writer has not yet decided this point, but will experiment with a view of ascertaining the best mean capacity.

The practical application of this form of phonograph for communications is very simple. A sheet of foil is placed in the phonograph, the clock-work set in motion, and the matter dictated into the mouth-piece without other effort than when dictating to a stenographer. It is then removed, placed in a suitable form of envelope, and sent through the ordinary channels to the correspondent for whom designed. He, placing it upon his phonograph, starts his clock-work and *listens* to what his correspondent has to say. Inasmuch as it gives the tone of voice of his correspondent, it is *identified*. As it may be filed away as other letters, and at any subsequent time reproduced, it is a perfect *record*. As two sheets of foil have been indented with the same facility as a single sheet, the "writer" may thus *keep a duplicate* of his communication. As the principal of a business house or his partners now dictate the important business communications to clerks, to be written out, they are required to do no more by the phonographic method, and do thereby *dispense with the clerk*, and *maintain perfect privacy* in their communications.

The phonograph letters may be dictated at home, or in the office of a friend, the *presence* of a stenographer *not being required*. The dictation may be as rapid as the thoughts can be formed or the lips utter them. The recipient may listen to his letters being read at a rate of from 150 to 200 words per minute, and at the same time busy himself about other matters. Interjections, explanations, emphasis, exclamations, etc., may be thrown into such letters, *ad libitum*.

In the early days of the phonograph, ere it has become universally adopted, a correspondent in Hong-Kong may possibly not be supplied with an apparatus, thus necessitating a written letter of the old-fashioned sort. In that case the writer would use his phonograph simply as a dictating-machine, his clerk writing it out from the phonograph at leisure, causing as many words to be uttered at one time as his memory was capable of retaining until he had written them down. This clerk need not be a stenographer, nor need he have been present when the letter was dictated, etc.

The advantages of such an innovation upon the present slow, tedious, and costly methods are too numerous, and too readily suggest themselves, to warrant their enumeration, while there are no disadvantages which will not disappear coincident with the general introduction of the new method.

Dictation.—All kinds and manner of dictation which will permit of the application of the mouth of the speaker to the mouth-piece of the phonograph may be as readily effected by the phonograph as in the case of letters. If the matter is for the printer, he would much prefer, in setting it up in type, to use his ears in lieu of his eyes. He has other use for them. It would be even worth while to compel witnesses in court to speak directly into the phonograph, in order to thus obtain an unimpeachable record of their testimony.

The increased delicacy of the phonograph, which is in the near future, will enlarge this field rapidly. It may then include all the sayings of not only the witness, but the judge and the counsel. It will then also comprehend the utterances of public speakers.

Books.—Books may be read by the charitably-inclined professional reader, or by such readers especially employed for that purpose, and the record of such book used in the asylums of the blind, hospitals, the sick-chamber, or even with great profit and amusement by the lady or gentleman whose eyes and hands may be otherwise employed; or, again, because of the greater enjoyment to be had from a book when read by an elocutionist than when read by the average reader. The ordinary record-sheet, repeating this book from fifty to a hundred times as it will, would command a price that would pay the original reader well for the slightly-increased difficulty in reading it aloud in the phonograph.

Educational Purposes.—As an elocutionary teacher, or as a primary teacher for children, it will certainly be invaluable. By it difficult passages may be correctly rendered for the pupil but once, after which he has only to apply to his phonograph for instructions. The child may thus learn to spell, commit to memory, a lesson set for it, etc., etc.

Music.—The phonograph will undoubtedly be liberally devoted to music. A song sung on the phonograph is reproduced with marvelous accuracy and power. Thus a friend may in a morning call sing us a song which shall delight an evening company, etc. As a musical teacher it will be used to enable one to master a new air, the child to form its first songs, or to sing him to sleep.

Family Record.—For the purpose of preserving the sayings, the voices, and *the last words* of the dying member of the family—as of great men—the phonograph will unquestionably outrank the photograph. In the field of multiplication of original matrices, and the indefinite repetition of one and the same thing, the successful electrotyping of the original record is an essential. As this is a problem easy of solution, it properly ranks among the probabilities. It comprehends a vast field. The principal application of the phonograph in this direction is in the production of

Phonographic Books.—A book of 40,000 words upon a single metal plate ten inches square thus becomes a strong probability. The advantages of such books over those printed are too readily seen to need mention. Such books would be listened to where now none are read. They would preserve more than the mental emanations of the brain of the author; and, as a bequest to future generations, they would be unequaled. For the preservation of languages they would be invaluable.

Musical Boxes, Toys, etc.—The only element not absolutely assured, in the result of experiments thus far made, which stands in the way of a perfect reproduction at will of Adelina Patti's voice in all its purity, is the single one of quality, and even that is not totally lacking, and will doubtless be wholly attained. If, however, it should not, the musical-box, or cabinet, of the present will be superseded by that which will give the voice and the words of the human songstress.

Toys.—A doll which may speak, sing, cry, or laugh may be safely promised our children for the Christmas holidays ensuing. Every species of animal or mechanical toy—such as locomotives, etc.—may be supplied with their natural and characteristic sounds.

Clocks.—The phonographic clock will tell you the hour of the day, call you to lunch, send your lover home at ten, etc.

Advertising, etc.—This class of phonographic work is so akin to the foregoing that it is only necessary to call attention to it.

Speech and other Utterances.—It will henceforth be possible to preserve for future generations the voices as well as the words of our Washingtons, our Lincolns, our Gladstones, etc., and to have them give us their "greatest effort," in every town and hamlet in the country, upon our holidays.

Lastly, and in quite another direction, the phonograph will *perfect the telephone*, and revolutionize present *systems of telegraphy*. That useful invention is now restricted in its field of operation by reason of the fact that it is a means of communication which leaves no record of its transactions, thus restricting its use to simple conversational chit-chat, and such unimportant details of business as are not considered of sufficient importance to record. Were this different, and our telephone conversation automatically recorded, we should find the reverse of the present status of the telephone. It would be expressly resorted to *as* a means of perfect record. In writing our agreements we incorporate in the writing the summing up of our understanding—using entirely new and different phraseology from that which we used to express our understanding of the transaction in its discussion, and not infrequently thus begetting perfectly innocent causes of misunderstanding. Now, if the telephone, with the phonograph to record its sayings, were used in the preliminary discussion, we would not only have the full and correct text, but every word of the whole matter capable of throwing light upon the subject. Thus it would seem clear that the men would find it more advantageous to actually separate a half mile or so in order to discuss important business matters, than to discuss them verbally, and then make an awkward attempt to clothe their understanding in a new language. The logic which applies to transactions between two individuals in the same office applies with the greater force to two at a distance who must discuss the matter between them by the telegraph or mail. And this latter case, in turn, is re-enforced by the demands of an economy of time and money at every mile of increase of distance between them.

"How can this application be made?" will probably be asked by those unfamiliar with either the telephone or phonograph.

Both these inventions cause a plate or disk to vibrate, and thus produce sound-waves in harmony with those of the voice of the speaker. A very simple device may be made by which the one vibrating disk may be made to do duty for both the telephone and the phonograph, thus enabling the speaker to *simultaneously transmit and record his message*. What system of telegraphy can approach that? A similar combination at the distant end of the wire enables

the correspondent, if he is present, *to hear it while it is being recorded*. Thus we have a mere passage of words for the action, but a complete and durable record of those words as the result of that action. Can economy of time or money go further than to annihilate time and space, and bottle up for posterity the mere utterance of man, without other effort on his part than to speak the words?

In order to make this adaptation, it is only requisite that the phonograph shall be made slightly more sensitive to record, and the telephone very slightly increased in the vibrating force of the receiver, and it is accomplished. Indeed the "Carbon Telephone," invented and perfected by the writer, will already well-nigh effect the record on the phonograph; and, as he is constantly improving upon it, to cause a more decided vibration of the plate of the receiver, this addition to the telephone may be looked for coincident with the other practical applications of the phonograph, and with almost equal certainty.

The telegraph company of the future—and that no distant one—will be simply an organization having a huge system of wires, central and sub-central stations, managed by skilled attendants, whose sole duty it will be to keep wires in proper repair, and give, by switch or shunt arrangement, prompt attention to subscriber No. 923 in New York, when he signals his desire to have private communication with subscriber No. 1001 in Boston, for three minutes. The minor and totally inconsequent details which seem to arise as obstacles in the eyes of the groove-traveling telegraph-man wedded to existing methods will wholly disappear before that remorseless Juggernaut—"the needs of man"—for will not the necessities of man surmount trifles in order to reap the full benefit of an invention which practically brings him face to face with whom he will, and, better still, doing the work of a conscientious and infallible scribe?—*North American Review.*

POWER FOR ELECTRIC ILLUMINATION.

THE electric light being simply the conversion into heat and light of the energy due to chemical action in a battery or of the energy developed by the consumption of fuel, and utilized through the medium of a motor and magneto-electric machine, the question which presents itself for consideration at the outset in contemplating the introduction of this mode of illumination is the cost of the necessary power. That the magneto-electric machine possesses immense advantages over the battery in point of economy and efficiency needs no demonstration here, and it is to the employment of that apparatus to which we have reference. According to late investigations by M. Tresca, 1,860 burners supplied with a current from a Gramme machine required 7 horse power or 4 horse power per 100 burners; when, however, a less powerful apparatus was used, producing but a single light, the expenditure was 1¼ horse power. So that, like all other commodities, the electric light is cheap at wholesale and dear at retail. Generally, however, it appears that 100 burners require 1 horse power, and by determining the cost of the latter the direct expense of the light is reached. To this, however, must be added cost of machinery, interest on capital, maintenance, wages, etc. For an approximate idea of the relative outlay we again have recourse to French investigations. M. Fontaine, in his recently published work, states that the electricity as a means of illumination is 75 per cent. cheaper than candles. M. Jamin, on the other hand, calls attention to published statements, wherein it is proved that the electric light is 65 per cent. dearer than gas, this assertion appearing in the *Annales des usines à gaz*. These opinions represent probably extreme views of the advocates and opponents of the general introduction of electric illumination. M. Jamin adds, however, that the Lontin Company in Paris are now offering to rent magneto-electric machines and all apparatus for producing the light at a cost of 10 cents per hour per hundred burners, the number of the latter and period of use to extend over certain contracted periods. The lights furnished to the Louvre by the Denayrouse-Jablochkoff Company, according to the same authority, far surpass gas lights in brilliancy, and an economy of about 30 per cent. is effected.

In the above cases power is furnished by consumption of fuel. There are many instances, however, where natural sources of power may be utilized, and it is to these more especially that we desire here to draw attention. Whether it will ever be practicable to employ the rise and fall of the tides in New York Bay or the currents in the rivers to actuate motors which in turn shall drive magneto-electric machines is at least an open question. The destruction of the reefs at Hell Gate has for one result the augmenting of the force of the current at the lower end of the island, and it would seem possible that some arrangement of water wheels could be contrived whereby this power might be utilized and a part of it used for supplying electricity for purposes of illumination. The same might be done on a small scale elsewhere. With a machine such as the Lontin, which is capable of giving a numerously divided current, or by the use of the simple Jablochkoff candle, where the entire paraphernalia of the electric lamp is obviated altogether, it would appear that the matter of lighting up a village or town by electricity has become an easy matter. A small water wheel, or even windmill, might furnish the power at little cost, and the remaining expenditures for maintenance would manifestly be small.

THE RADIOMETER AND THE SPHEROIDAL STATE.

THE following lucid exposition of the latest theories explaining the action of Crooke's radiometer, and the cause of the phenomenon known as the spheroidal state, was given by Professor Barrett in a recent lecture at the London Institution. He said: "To Mr. Stoney is unquestionably due the great honor of having been the first fully to explain the true theory of the radiometer." It was in the course of these investigations that Mr. Stoney has been quite recently led to show that the force which is so active in the high rarefication (that is necessary for the effective rotation of the radiometer) is also present at ordinary atmospheric tensions. Now, it is this force which forms the new explanation of the spheroidal state. In order to understand the action that occurs it must be recollected that, according to calculation, the number of molecules of air that at ordinary pressure occupies the space of a pin's head is 1,000,000,000,000,000,000; when the radiometer globe is exhausted of these molecules of air, as far as we can do it by mechanical means, there are still some few millions remaining, and these are in constant motion. Heat makes them move more rapidly, cold more slowly. If we have two surfaces placed very near each other, one surface hot and the other cold, from the hot surface the molecules will be thrown off with greater rapidity than they reached it; and if the cold surface be near enough they will "bombard" it. Hence there will be a tendency in the hot and cold surfaces to retreat from one another, and when with one of these, as in the radiometer this is possible, it ensues, this force would obviously disappear (1) if the residual molecules could be wholly removed or so lessened in number that their action would be insensible, or (2) if the surfaces were so far apart that the augmented molecular activity had expended itself before reaching the cool surface. Applying the same kind of reasoning to the spheroidal state of liquids, we can see that it is only at relatively short distances from the metal that the interaction will occur. Professor Barrett showed by experiment that the spheroidal state could be produced with fluids from which there could be no vapor given off, as the old theory required, and also that it could be produced in cases of very slight differences of temperature.

THE HAIR HYGROMETER.

DR. KOPPE, of Zürich, publishes in the *Austrian Journal* for February 15 an ardent plea for the reintroduction of the hair hygrometer. He shows by Prof. Wolf's experiments the utter untrustworthiness of observations with the wet and dry bulb thermometers near the freezing-point—a fact which is self-evident from the records of the self-registering thermometers given in the Quarterly Weather Reports—and argues that if at the central observatory of Zürich the experience of the instrument is unsatisfactory, it must be utterly undeserving of credit at outlying stations. The modern form of the hair hygrometer is due to the late Goldschmid of Zürich, and the main feature in it is that while in the old instrument the hair is adjusted to indicate the true values of humidity by altering its length till the index marks 100 at a time of fog, in Goldschmid's instrument this adjustment can be effected at any time. A wooden frame covered with muslin is introduced into the case of the hygrometer. If this muslin be wet, the hair is at once brought into a state of complete saturation, whatever be the temperature or the hygrometrical condition of the air. The weight employed for stretching the hair is not more than half a gramme, while the average strength of a hair is 100 grammes. Dr. Koppe maintains that a hair so prepared will give very satisfactory results, and his practical experience is that one of these instruments has worked without deterioration for many years at Zürich. The actual arrangement proposed is a combination of the two types of instrument. The dry bulb thermometer is inclosed in the same case as the hair hygrometer, and the wet bulb thermometer is placed outside.—*Academy.*

CERTAIN CONSEQUENCES OF THE CONSTITUTION OF THE SOLAR SPECTRUM.—A. CORNU.—The author has been led to the conclusion that the position and relative brightness of the dark rays of the solar spectrum may be explained by the action of an absorbent stratum existing upon the sun, analogous in its chemical composition to that of volatilized aerolites. He infers also that the center of the earth consists chiefly of metallic masses, and especially of iron.

TRANSIENT VARIATION OF PERMANENT MAGNETISM.—J. M. GAUGAIN.—The transient variation of a bar is positive when the bar has been magnetized at a temperature of about 350°, and negative when the magnetization has been performed at any temperature not exceeding 100°. The temperature at which the transient variation = 0 varies in different bars of steel.

GELATINE NEGATIVES.

By REV. H. J. PALMER, M.A.*

THE recent publication of a new film process of exceeding simplicity, and one which may be readily accomplished in all its operations by every amateur who pleases to make the attempt, has elicited so much notice in many directions that I have ventured once more to trespass upon your time and patience, in the hope that I may augment the interest of our meeting to-night by enabling you to witness all the details of this process from beginning to end, and also that I may convey additional information to the many who are seeking it on this subject.

My first proceeding is to take a clean glass of quarter-plate size, and, having placed it upon a level surface, I pour upon it three drachms of a thirty-grain solution of gelatine in dilute ox-gall. I distribute the pool from the center to the edges of the plate, with the help of the tip of the forefinger, which answers better for the purpose than a glass rod, and then remove possible bubbles with the point of a penknife. For this preliminary film, as well as for the emulsion itself, I find that Nelson's opaque is better adapted than the clear photographic gelatine. The latter does not leave the glass so readily, and the opacity of the former effectually prevents blurring, and, at the same time, does not affect materially the printing capacity of the negative.

The remarks on the subject of halation made at the last meeting of the Edinburgh Photographic Society had reference, I imagine, to gelatine negatives on glass, and not to these film pictures. I have never met with the slightest tendency to blurring in my films, and the entire absence of it when opaque gelatine is employed enables me to give up the plan I had first adopted, namely, of backing up each film with a glass coated with colored gelatine and sugar. In the film negative of the "Interior of Wallasey Church" the large east window is as clear and sharp in all its detail as would be the case with a wet plate. I have exposed dry plates of all kinds upon this subject, and, in spite of a backing of color, blurring invariably takes place at this point in the picture.

We now sensitize our dried film by pouring upon it a pool of emulsion, and distribute the latter over the surface with the tip of a *clean* finger. To avoid waste of emulsion this operation is better conducted upon a dish or tray, and any spilt gelatine may be restored to the vessel of emulsion for further use. It is important that the proportion of gelatine per ounce be the same in both the preliminary and the sensitive coating. If this be not the case, the film will curl and give trouble under the developer. Some gelatines which I have been using lately manifest a tendency persistently repellent of the emulsion. When this is the case it is better to add a few drops of ox-gall to the latter. It will now flow better over the surface, but will still require to be humored a little by tilting the glass toward each side in succession, so that the surplus emulsion may run round the edges of the plate two or three times.

When thoroughly dry the film is readily stripped from the glass, and may be exposed in the camera. The best method of securing a sufficient "taut" surface in the dark slide is, in the first instance, to make the sheet slightly longer than the required size. It is then laid face down upon a sheet of blotting paper; a glass is pressed into close contact with it, the two ends are moistened with the tongue, folded over, and so fastened to the back of the glass support. In changing the film a knife readily effects the separation, and the glass is ready for a fresh sheet.

Mr. Kirkby has suggested that these films should be prepared upon ferrotype plates of the larger size, so that a perfectly rigid support may be provided for use in the dark slide. I have tried this plan, and find that the plate will take the gelatine as readily as glass. It will be necessary to secure perfect flatness of the plate during the coating, and the film will strip off for development and printing with perfect ease.

Of the requisite exposure I need say little. It will suffice to mention that the films I am about to develop were exposed in bright sun at 8:30 A.M. yesterday, with Dallmeyer's rapid rectilinear, stop No. 2, for twenty seconds. I place the film in a dish of water for a few moments, pour this off, flow over a ten-grain solution of bromide of potassium, and then follow with the ordinary alkaline developer. When detail is fully out if necessary I apply an acid silver intensifier, and then fix with hypo., washing copiously before and after each operation. The negative is conveniently kept from slipping into the sink by the assistance of a camel's-hair brush, and the latter useful little accessory helps me to draw the finished film on to a glass plate, and also to sweep out any air-bubbles which may have interposed between the surfaces.

The films must be allowed to dry spontaneously, or inevitable cockling or splitting will be the result. When desiccation is complete, a knife is inserted under one corner, and then swept rapidly beneath the edge of the film. A pause in this operation will sometimes cause a sudden crack across the negative, as will also the temperature of a hot room. It is essential that no attempt be made to remove the negative from the glass upon which it has dried until all tackiness of surface has disappeared. If this be neglected, the resulting negative will be useless until it has been wetted and redried, like the specimen I have here.

One word of caution is necessary with regard to density. What would be considered a decidedly weak negative in any other dry process will be found to possess sufficient printing vigor in the case of a gelatine film.

* Read before the Liverpool Amateur Photographic Association.

PATIENCE IN DRY PLATE PHOTOGRAPHY.

THE advent of sunny days and clear skies is welcome to none more than the dry plate photographer. He has patched up his dark tent, if he carries one, during the winter, and corrected the defects of his apparatus, or possibly perfected that dry plate process which, for sensitiveness and simplicity, is to beat all the world. He is only waiting for the spring, or early summer, to begin work, for the time when the foliage is just set, and when there are still masses of white cloud floating about to aid in softening sunlight effects and adding transparency to his shadows. If he can get a still day, when the warm sunshine comes and goes, lighting up hilly landscapes like patchwork, the horizon clear and transparent from recent rains, and the distant cliffs sharp and bright against the sky, it is all he wants, unless, indeed, he has it in his mind to have a bit of water in his picture. Then he seeks out some placid pool, or lazy stretch of river where contrast is afforded by the yellow reeds and overhanging green of the willow, and sets down his camera where a fallen tree or a patch of bushes composes a picturesque foreground. In all probability he has had the spot in his eye for the past few months, and has studied the standpoints half a dozen times, in which case there is little left in the way of adjusting apparatus and focusing. He knows what he will get long before he has developed the plate, and congratulates himself already, as if the picture were hanging up in the library at home.

But he must be a patient man. No dry plate worker was ever successful in his calling who was flighty and hurried in his manipulations. It is like angling. No fisherman ever yet had a good day's bottom-fishing who could not go to work systematically, or had a deficiency of patience. We have heard of a dry plate photographer who actually desisted from his work to apply a coating of whitewash to a cottage, in order to throw the high light of his picture in a certain point, and the result was one well worth waiting for. A fine picture of the Thames near Cookham, in our possession, would have been sadly marred by an ugly fence that occupies a prominent position in it, had not the photographer spent some time in tastefully twining a bit of ivy round one of the posts, and thus broken its rigid outline. Now it is as if the post had actually been chosen as an appropriate foreground, instead of being, as it was, an adjunct impossible of removal. Again, there is a light breeze, or a big cloud that for the moment gives an inky aspect to the water, and chills the whole pleasant scene before you. Exposure at that instant would have been to render your former work vain, and to produce a mediocre picture, instead of one full of life and brightness. You must sit down and bide your time. Take a book with you, if you like, and read. But do not expose after all your trouble. The chances are that by the time you have removed your plate, the proper moment will have arrived. Half in sunshine, half in shadow, will produce your best picture, in which the shadows will be transparent and the atmosphere transparent.

And patience, more than ever, is necessary in the development of dry plates. Do not hurry. Inform yourself well beforehand what it is you are about to develop. Is there much dark foliage about it that will require working up, or does it present a delicate skyline which will rapidly fog? Proceed slowly and cautiously, but when the right degree of development has been reached, then act promptly. Do not allow your shades of distance to fog by pushing to extremes; intensifying, can always be managed afterward, when the picture is fixed, you must remember. At the same time, in the case of foliage and undergrowth, they are nothing unless fully developed, in the same way as their beauty is wholly lost if there has been any shaking during exposure. In a word, if you cannot be patient, you will never be a good dry plate photographer.—*Photographic News.*

NEW printing inks, based upon gas-tar, are coming into use in France. They are said to consist of 10 parts tar, 36 parts lampblack, Prussian blue 10 parts, and glycerine 10 parts, the oils, gum-resins, etc., present in ordinary printing ink being dispensed with.

HOW GRANITE IS POLISHED.

NOTHING more elegant is now employed in architecture than the polished granite pillars which adorn many of the trade palaces of Boston and other large cities. These pillars always attract such attention and admiration that it may not be uninteresting to describe briefly the method employed in polishing them.

The substances used in grinding and polishing granite shafts are beach sand and emery, applied in certain quantities at a certain velocity of revolution for the column, as the work is done in a lathe similar in some respects to the lathes for turning and polishing metals and woods, except that the spindles both revolve, that in the foot-stock as well as that in the head-stock. The lathe is driven at different speeds to suit the diameter of the shaft to be ground and polished, for a uniform surface speed of two hundred and thirty to two hundred and forty revolutions per minute is required for the work, and it is evident that while a shaft of twelve inches diameter would have to revolve about seventy-seven times per minute, one of three feet diameter would require only one-third that rotary speed, or about twenty-five turns.

The centers of the columns are found on the ends by measurements, and proper boxes are secured into cavities made for the purpose, and the column is then swung in the lathe. At the rear of the lathe, extending its entire length, is a bulkhead, or wall, against which rest the ends of a series of polishing blocks, which lie on the top of the revolving column, the direction of the revolution of which is toward the bulkhead, thus holding the polishing blocks in place. These blocks are of cast iron about three inches wide, long enough to reach across the column and of sufficient thickness to weigh about one hundred pounds each for a column of forty inches in diameter and of fifty pounds for one of twenty inches.

The under sides of the blocks are concaved to nearly a segment of a circle representing the cross section of the column, and when in place for work are ranged closely side by side, covering the entire length of the column. Their motion may be likened to that of the keys of a piano, particularly when the work is first begun and until the "stunt" bruises, or tool marks of the chisel, are removed. An attendant feeds these blocks with sand and water until all the tool marks are removed and a uniform surface is obtained. Then emery is used, the grade being what is known in commerce and among mechanics as that of number forty, and from that to number sixty, according to the relative hardness of the stone.

The emery must all be weighed and put in at one time, otherwise the addition of new emery would make scratches, for when the stone is finished the emery becomes an almost impalpable mass, finer than the finest emery flour. The amount weighed is estimated by the surface to be polished, being at the rate of about half a pound per superficial foot. Thus for a column ten feet long and three feet diameter, equaling about ninety superficial feet, the amount of emery required would be from forty-five to fifty pounds. After the emery has been once fed through and fallen into a trough underneath the revolving column, it is all carefully removed into a tub, and re-fed to the blocks.

After a good surface is secured, the final polish is obtained by means of oxide of tin and water, the bearing surfaces of the polishing blocks being faced with felt. The time employed in the entire processes varies according to the size of the column and the quality of the stone, a granite shaft ten feet long and fourteen inches diameter requiring from forty-five to fifty hours actual working time. The result is a surface polish of remarkable brilliancy, contrasting in architectural work elegantly with carved caps and dressed bases.—*Commercial Bulletin.*

CLEANING OLD ENGRAVINGS.

A CORRESPONDENT of the *Chemist and Druggist* says upon this subject:

A correspondent from Wells recommends cold water, care, and common sense, with a warning not to use destructive chemicals. Being myself a hard-working member of an art class, I may say that we all fully appreciate simple expedients, but when many years have passed, and brown spots make their appearance, or rings of mildew, or yellow patches of discoloration, plentiful cold water and undirected common sense are equally of no avail.

No one who values an engraving will try a chemical receipt until plain remedies have been essayed. I have cleaned a set of 760 manuscripts, more or less illegible, in the following manner:

A large German sitz bath is made perfectly clean; half filled with water filtered through a carbon filter. The manuscript is floated on the water, *face downward*, for twenty-four hours, the color obtained being sufficient evidence as to what has taken place. The manuscript is lifted out of the water by a large, perfectly clean sheet of window glass being passed underneath; after being drained it is transferred to a sheet of white blotting paper, never being touched by the hand. When thus the first dampness has been removed, it is transferred to fresh blotting paper, dried and ironed in the usual way.

This plan will serve in the case of nine engravings out of ten—excepting always that, before ironing, the engraving is finished off with bread crumbs applied by a circular motion of the hands, as practiced in the art schools.

This plan, with regard to ancient stains, mildew, and grease spots, is ineffective, and recourse must be had to other means.

I have received this extract:

"REMOVING MILDEW STAINS.—The most successful method is to immerse each mildewed sheet separately in a solution made in the proportions of half a pound of chloride of lime to a pint of water. Let it stand, with frequent stirring, for twenty-four hours, and then strain through muslin, and finally add a quart of water. Mildew and other stains will be found to disappear very quickly, and the sheets must then be passed separately through clear water, or the chloride of lime, if left in the paper, will cause it to rot. Old prints, engravings, and every description of printed matter may be successfully treated in the same manner."

The objection to this method is that an unnatural whiteness is effected, which in printed matter is of no consequence, but seriously interferes with the beauty of a line engraving. The formula which I still want includes two solutions—one of Eau de Javelle, and the other probably of hyposulphite of soda. It was copied from a periodical about four months ago, but it was burnt just as it was being used.

He quotes from one of his correspondents, thus:

"I am a great admirer of old engravings, and collect them, particularly old portraits, and have in my time cleansed many hundreds. The plan which I adopt is as follows:

"I place them, one or two at a time, in a shallow dish, and pour water over them until they are completely soaked or saturated with it. I then carefully pour off the water, and pour on to the prints a solution of chloride of lime (1 part liq. calcis chlorate, B. P., to 39 parts of water). As a general rule, the stains disappear as if by magic, but occasionally they are obstinate. When that is the case I pour on the spot pure liq. calcis chlorate, and if that does not succeed, I add a little acid nitro-hydrochlor. dil. I have never had a print which has not succumbed to this treatment—in fact, as a rule, they become too white. As soon as they are clean, they must be carefully washed with successive portions of water, until the whole of the chlorine is got rid of. They should then be placed in a very weak solution of isinglass or glue, and many collectors color this solution with coffee grounds, etc., to give a yellow tint to the print. They should be dried between folds of blotting paper either in a press or under a heavy book, and finally ironed with an ordinary flatiron to restore the gloss, etc. (place clean paper between the iron and the print)."

PROCESSES FOR THE PREPARATION OF VIOLET ULTRAMARINE.

1. If dry chlorine is passed over blue or green ultramarine heated above 572° Fahr., chlorine derivatives of ultramarine are formed. The color turns first more greenish, then to a dark reddish, and if in this state it is thrown into water, or into the solution of an alkaline carbonate or hydrate, the chlorine is liberated either as muriatic acid or in an alkaline chloride, while violet ultramarine is deposited.

In an analogous matter anhydrous sulphuric acid passed through ultramarine heated to about 302° forms a reddish sulpho-derivative, which, if thrown into caustic or carbonated alkaline lye, is resolved into an alkaline sulphate and violet ultramarine.

2. If blue or green ultramarine is heated to 320° or 358° Fahr., and if into the warm mass chlorine is conducted along with steam, violet ultramarine is formed at once along with common salt (chloride of sodium), which is washed away in water. For the processes one or two chests of wrought iron are used about 78 inches long, 29 inches broad, and 21 inches high, and built into a stove of masonry.

The ultramarine is sifted and laid to the depth of 4-10ths of an inch upon earthernware plates, which are provided with feet 1·179 inch high, by means of which they can be piled one over another till the chest is full. Each chest holds sixteen rows of plates, set fourteen deep one upon another, so much space only being left that two leaden pipes can be passed in down to the bottom, one at the front and one at the back end of each chest, through which the chlorine gas can be introduced.

Each chest has two apertures, 11¾ inches broad by 17¼ inches long, through which the plates are introduced, and which can be closed by iron lids secured by screws. In each of these lids is an aperture for the introduction of a thermometer, and in the hinder one there is also a hole about 4 inches wide, through which the escaping gases pass, and are led by stone-ware pipes into the chimney.

Subsequent experiments gave an equally favorable result with an apparatus consisting of a wrought-iron drum revolving round a fixed hollow axle, which within the drum is provided with holes on its under side.

At one end the chlorine gas was passed into the hollow axle by means of a leaden pipe, and also a thermometer. At the other end of the axle the escaping vapors were received into stone-ware pipes and led into the chimney. Within the drum iron scrapers were also attached to the axle in order to scrape off the color adhering to the inside of the drum, and keep all parts of the mass exposed to the air. The connection between the axle and the revolving drum was secured air-tight by means of stuffing-boxes, containing fibrous material, *e.g.*, asbestos, soaked in tallow. Heat was applied by means of an iron stove.

For the second process the following apparatus is used to mix the chlorine gas with watery vapor. This was effected formerly in glass or stone-ware vessels, but troughs hollowed out of compact sandstone, and provided with lids of the same material, are now preferred. The lid is secured upon the trough with a linseed-oil luting, and through this, down to the bottom, pass two stone-ware pipes, one introducing chlorine gas and the other steam. Two lead pipes, only just entering the lid, convey the mixture of chlorine and steam to the lead pipes above mentioned, and thus into the iron chests. A glass tube bent at right angles is also inserted in the trough so that one of its legs lies horizontally at the bottom of the trough, while the other rises perpendicularly through the top, and serves for the introduction of water and as a gauge. The trough is large enough to hold 17 pints. About 5¼ pints of water are poured into the trough and steam is then admitted till the water is brought to a moderate boil. The apparatus for developing chlorine is then set to work, so that chlorine steamed through the boiling water and becoming saturated with steam enters the apparatus filled with ultramarine, heated to 320° F., whereupon the formation of the violet color begins and is complete in about two hours.

Third process.—If blue or green ultramarine is mixed with nitrate of ammonia and sal-ammoniac, or with nitrate of soda and sal-ammoniac, violet ultramarine is formed and obtained in a state of purity by washing with water.

Fourth process.—If blue or green ultramarine is heated to 320°-356° F., and exposed to the action of an acid, an oxidizing agent, or of water, or a mixture of all three, a more or less complete conversion of the ultramarine into the violet variety takes place.

Ultramarine mixed with chloride of calcium or of magnesium, fitted loosely into a crucible and heated, changes its shade to violet-blue or to violet. The same color is formed when muriatic acid gas, steam and air, or when vapors of aqueous nitric acid are passed over heated ultramarine.—J. ZELTNER, German patent, No. 228, 1877.

COPYING INK.—According to the *Papier Zeitung*, the so-called Paris copying ink—which, as it flows from the pen, has a somewhat reddish cast, but turns quickly blue upon the paper, gives distinct blue-black copies, retains its fluidity well, and does not, like the common violet-black copying inks, grow muddy, and deposit a sediment—is prepared as follows: In 35 fluid ozs. of extract of logwood, at 10° B., dissolve 155 grains of alum, and add enough lime-water to form a permanent precipitate. A few drops of a weak solution of chloride of lime are then added, until the sediment takes a distinctly blue-black color. Dilute muriatic acid is then added, drop by drop, until a distinct reddish solution is obtained. The ink is then ready for use; but for copying 75 grains of glycerine are added. Dr. Reimann, in the *Faerber Zeitung*, gives the following receipt: Dissolve 17¼ ozs. of solid extract of logwood in 525 fluid ozs. of water, and add 387 grains of yellow chromate of potash, 17¼ ozs. alum, 21½ ozs. gum arabic, and 17¼ ozs. sugar-candy. When all is dissolved, 17¼ ozs. of muriatic acid are stirred in drop by drop. If the ink is not to copy, the gum and sugar are omitted.

IMPROVEMENTS IN ANILINE BLACKS.

By ANTONY GUYARD.

DYEING with aniline black is a question of enormous interest and full of actuality. It was lately a difficult and delicate problem, but the reactions recently discovered have solved it in the happiest and most unexpected manner. The mixtures of vanadium contain no sensible amount of metallic salts, the traces of chloride of vanadium introduced having no sensible effect upon the doctors. As compared with the sulphide of copper mixtures they offer the advantage of perfect homogeneity and of a solubility which permits them to be applied upon all tissues. We may add that they offer all the advantages of the original mixtures of Lightfoot without any of their inconveniences. They require, it is true, to be manipulated with care and precaution, but with the addition of the "preservative salt" of Castelhaz, difficulties disappear, and the last objections and obstacles to the use of the aniline black are overcome.

To prepare the color for printing we dissolve ⅞ ounce to 1¼ ounce of the chlorate of soda in 17 fluid ounces of water, and thicken in the ordinary manner.

At the same time 17 fluid ounces of water are thickened in another vessel, and 2¾ ounces muriate of aniline with 1½ grain of chloride of vanadium are stirred into it. The whole dissolves rapidly. Equal measures of the two pastes are mixed and printed on the muslins as rapidly as is wished.

As the black is readily developed, no more than the quantity strictly necessary must be mixed at once, and here, as well as in dyeing, it is necessary to age at a low temperature as long as chlorine is given off, and to raise the heat afterward until completely dry. The pieces are then passed through bichromate of potash, which completes the process. Nothing can equal the beauty of the blacks thus produced.

In dyeing the choice of the chlorates is unimportant, and I admit that I have never obtained better blacks than with the chlorate of potash. Its only fault is imperfect solubility, and the dyer will, therefore, find a mixture of equal weights of the chlorates of potash and soda answer all his requirements.

In printing, the chlorate of potash is unsafe, because it is apt to crystallize on the surface of the colors, and produce accidents by blurring the patterns and smearing the grounds. Hence the chlorate of soda must be exclusively employed. In all cases, however, the "preservative salt" should be added to the aniline black, or rather to the mixtures from which it is prepared.

It is very important, to avoid excessive temperatures in the aging-room, not to pile the pieces upon each other while still moist, and not to hang them up too near each other in chambers insufficiently ventilated.

The preservative salt of Castelhaz has the valuable property of absorbing or completely neutralizing the acids, the chlorine and the chlorated products given off during the development of the black. Hence the fiber is preserved from corrosion, other colors previously printed are not discharged or impoverished, and last, but not least, the health of the workmen is not exposed to injury.

This salt is perfectly soluble in water, and is no less useful in dyeing than in printing. If a slow development of the black is desired, ½ to 1 part of the preservative salt may be used to each part of the chlorate of aniline, but if a more rapid development of the black is wished, or if other colors have been printed on before the black, the proportions may be raised to 1 to 1½. These proportions refer to dyeing as well as to printing.—*Teinturier Pratique.*

IMPROVEMENTS IN ANILINE COLORS.

BRUNNER and Brandenburg report, in the *Berichte D. D. Chem. Ges.*, the results of their operations as to the use of bromine in the manufacture of aniline colors, especially aniline violet and diphenylamine blue. To three molecules of well-cooled and chemically-pure dimethylaniline they added three molecules of bromine in a thin stream, when a little hydrobromic acid gas escapes, but its development becomes much more abundant when the temperature rises to 248° Fahr. The tough, dirty-green product is either mixed with a little acetic acid, and then kneaded into thin cakes, with quartz sand, and heated in the air-bath to 248° F., or it is at once heated in the oil-bath to the same temperature, being constantly stirred until a portion taken out congeals and separates on the addition of water with a coppery luster. The purified coloring substance is a deep blue mass with a coppery reflection, readily deliquescent on exposure to air, soluble in alcohol, and dyeing silk and wool as intensely as BBBB (a very blue violet). If heated above 248° F. hydrobromic acid continues to escape, and redder dyes are formed; at 290° F. a reddish violet equal to BB, at 320° F. a shade resembling B. Between 338° and 356° F. a product is obtained which dyes silk a fine red brown.

Three molecules of dimethylaniline, three of chloride of benzyl, and two of bromine, heated to 248° F. for four hours, yielded a sea-green product, soluble in water, along with a small quantity of a dye soluble in alcohol but insoluble in water. If one or two molecules of benzyl chloride are used to three of dimethylaniline, the authors obtained light or dark benzylated violets, which, like the blue green, are solid and of a coppery luster. For the synthesis of triphenylrosaniline (the basis of diphenylaniline blue), two molecules of diphenylamin and two of orthotoluidine were dissolved in glacial acetic acid, and six molecules of bromine were gradually added. The glacial acetic acid was then distilled off, and heat was applied for some hours, first to 302° F., and afterward to 356° F., until the mass became solid, and displayed a coppery luster. The purified color is scarcely soluble in water, readily in alcohol, with a splendid blue color, and dyes silk like BBB. The authors obtained sulphonic acid compound of the same as a dark-blue powder, perfectly soluble in water, and dyeing silk and wool blue.

Pure aniline, and aniline with toluidine (solid or liquid), and corresponding quantities of bromine, yielded in every instance rosaniline along with traces of a violet-blue dye, insoluble in water.

GRISOPHENYLAMID is a coloring matter invented by J. Roth. It is prepared by the prolonged exposure of a mixture of solid carbonate of ammonia and anhydrous phenylic acid to heat in a closed vessel. It yields upon silk and wool fine gray shades, said to resist acids, soap, and sunlight.

BISMUTH—A COMPARISON OF THE METHODS FOR ITS ESTIMATION.

By THOS. B. STILLMAN, M. Sc.

BISMUTH has of late years assumed considerable importance in the arts, and the technical chemist is frequently called upon to examine alloys, medicinal and pharmaceutical preparations, toilet articles, paints, pigments, etc., containing it as an essential constituent or as an adulteration. With a view to determine the relative accuracy of the different methods for its estimation, as well as the chances of error as applied to commercial work, I have recently made a critical comparison of the same, and present a brief below.

The methods, as suggested by Fresenius, are as follows:

a, as oxide, by precipitation as carbonate.
b, as oxide, by ignition.
c, as oxide, by evaporation.
d, as sulphide.
e, as arsenate.
f, as chromate.
g, as metallic bismuth.
h, as iodate of bismuth (volumetric).

In each of the following determinations 50 c.c. of a solution of 25 grammes of bismuth nitrate in 2 liters of water were used, and, to insure greater accuracy, were weighed:

a. Determination as Oxide, by precipitation as carbonate:

The solutions of bismuth were mixed with carbonate of ammonia in *slight excess*, warmed sometime nearly to boiling, filtered, dried, and ignited in porcelain crucibles, the process of ignition converting the carbonate into the oxide.

I. 51·4432 grammes of solution gave 0·3032 gramme Bi_2O_3 = 0·5283 per cent. Bi.

II. 51·3459 grammes of solution gave 0·2708 gramme Bi_2O_3 = 0·5275 per cent. Bi.

III. 51·6004 grammes of solution gave 0·3040 gramme Bi_2O_3 = 0·5282 per cent. Bi.

Average per cent. Bi = 0·5280.

b. By Ignition:

Three samples were evaporated and then ignited in porcelain crucibles until the weights remained constant, with the following results:

I. 51·2672 grms. solution gave 0·3014 grm. Bi_2O_3 = 0·5273 per cent. Bismuth.

II. 51·3568 grms. solution gave 0·3019 grm. Bi_2O_3 — 0·5270 per cent. Bismuth.

III. 51·0667 grms. solution gave 0·3000 grm. Bi_2O_3 — 0·5267 per cent. Bismuth.

Average — 0·5270 per cent. Bismuth.

c. By Evaporation.—Method given by J. Löwe (*Journ. f. Prackt. Chemie*, lxxiv., 344):

The solution of the nitrate was evaporated in a porcelain capsule on the water-bath till the neutral salt remained in a syrupy solution; added water, loosened the white crust that formed with a glass rod from the sides, evaporated again on the water-bath, and repeated the whole operation four times.

After the dry mass on the water-bath had ceased to smell of nitric acid it was allowed to cool thoroughly, and then treated with cold water containing a little nitrate of ammonia (1 in 500); after the residue and fluid had been a short time together, filtered, washed with weak solution of nitrate of ammonia, dried, ignited, and weighed as oxide.

I. 50·9808 grms. sol. gave 0·2995 grm. Bi_2O_3 — 0·5266 per cent. Bi.

II. 51·1758 grms. sol. gave 0·3011 grm. Bi_2O_3 — 0·5275 per cent. Bi.

III. 51·0738 grms. sol. gave 0·3004 grm. Bi_2O_3 — 0·5272 per cent. Bi.

Average — 0·5271 per cent. Bi.

d. Determination as Sulphide:

The solution was diluted with water, slightly acidified with acetic acid (to prevent the precipitation of a basic salt), and the bismuth precipitated with hydrogen sulphide.

The precipitate was collected upon a weighed filter, dried at 100° C., and weighed. The weighing required caution, as at first the precipitate loses weight by the evaporation of water; then it gains weight from the absorption of oxygen. Hence the weighings were made every half hour and the lowest weight taken as the correct one.

I. 51·4666 grms. sol. gave 0·3341 grm. Bi_2S_3 — 0·5271 per cent. Bi.

II. 51·7088 grms. sol. gave 0·3350 grm. Bi_2S_3 — 0·5260 per cent. Bi.

III. 51·9848 grms. sol. gave 0·3371 grm. Bi_2S_3 — 0·5266 per cent. Bi.

Average — 0·5265 per cent. Bi.

e. Determination as Arsenate:

H. Salkowski (*Zeitsch. f. Analytische Chemie*, viii., 205) recommends, since arsenate of bismuth is insoluble in nitric acid, that bismuth be thus estimated. Arsenic acid was added in slight excess, with constant stirring, so that the crystalline precipitate formed would not attach itself to the sides of the beaker; allowed to stand for one hour without warming, filtered upon a weighed filter, washed with water until the filtrate showed signs of turbidity, dried at 120° C. and weighed.

I. 51·5350 grms. sol. gave 0·4627 grm. bismuth arsenate — 0·5289 per cent. Bi.

II. 51·6382 grms. sol. gave 0·4668 grm. bismuth arsenate — 0·5273 per cent. Bi.

III. 51·4218 grms. sol. gave 0·4636 grm. bismuth arsenate —0·5266 per cent. Bi.

Average — 0·5276 per cent. Bi.

f. Determination as Chromate (*Journ. f. Prackt. Chem.*, lxvii., 464):

The solution of bismuth was *poured* into a warm solution of bichromate of potassa in a porcelain capsule, stirred, taking care to leave the alkaline chromate slightly in excess. The precipitate was orange yellow and dense throughout; boiled the contents of the dish for ten minutes, with stirring; then washed the precipitate, first by repeated boiling with water, and decantation on a weighed filter, at last thoroughly on the filter with boiling water; dried at 120° C., and weighed.

I. 51·3451 grms. sol. gave 0·4307 grm. bismuth chromate — 0·5247 per cent. Bi.

II. 51·3400 grms. sol. gave 0·4312 grm. bismuth chromate — 0·5261 per cent. Bi.

Average per cent. Bi — 0·5254.

g. Determination as Metallic Bismuth.—Method of H. Rose (*Pogg. Annal.*, xc., 104, cx., 136):

The excess of nitric acid was nearly neutralized with ammonia chloride of sodium added and then a rather large quantity of water. After allowing to stand for some time, tested whether a portion of the clear supernatant fluid was rendered turbid by a further addition of water; after filtering, washed completely with cold water and dried.

The precipitate was carefully removed from the filter, the filter incinerated in a porcelain crucible, allowed to cool, the precipitate added thereto and reduced to metallic bismuth by fusion with cyanide of potassium.

In this fusion it sometimes happens that the crucible is attacked, and particles of porcelain are found mixed with the metallic bismuth. This was prevented from injuring the analysis by weighing the crucible together with a small filter before the experiment, collecting the metal on the filter, drying and weighing the crucible again with the filter and bismuth.

I. 51·6808 grms. sol. gave 0·2682 grm. Bi — 0·5189 per cent. Bi.

II. 51·4238 grms. sol. gave 0·2669 grm. Bi — 0·5188 per cent. Bi.

III. 51·3038 grms. sol. gave 0·2630 grm. Bi — 0·5130 per cent. Bi.

Average per cent. Bi — 0·5169.

h. Volumetric Determination of Bismuth (Buisson & Ferray, *Moniteur Scientifique* [third series], iii., 90):

This method is based upon the insolubility of iodate of bismuth in acetic acid. Briefly stated, the process is as follows:

0·500 gramme nitrate of bismuth is dissolved in a small quantity of water containing free nitric acid; bicarbonate of soda is added, in powder, until a permanent precipitate is formed. This is dissolved by the addition of acetic acid. The clear solution is transferred to a ½ liter flask, 25 cubic centimeters iodic acid solution added, and water up to 250 c.c. After shaking well it is filtered through a *dry* filter into a *dry* flask; 100 c.c. of the filtrate are taken, potassic iodide and sulphuric acid added, and titrated with hyposulphite of soda solution. The excess of iodic acid used is thus found for 250 c.c. This excess, subtracted from the 25 c.c., gives the amount combined with the bismuth. The standard solution of iodic acid was formed by dissolving 30 grammes of the crystallized salt in a liter of water. The hyposulphite solution was such that 93·05 c.c. corresponded to 25 c.c. of the iodic acid solution. The solutions were standardized by means of two samples of C. P. Bismuth, each sample weighing 0·250 gramme.

I. 0·250 grammes bismuth treated as above directed; 25 c.c. of iodic acid used. 100 c.c. filtrate from iodate of bismuth required 13·17 c.c. of the hyposulphite solution; 250 c.c., or entire filtrate, required 32·95 c.c. hyposulphite solution. From this we find 60·10 c.c. of the hyposulphite solution corresponds to 0·250 gramme bismuth.

II. In the same manner 0·250 gramme Bi required 60·09 c.c. of the hyposulphite solution.

Three samples of the original solution of bismuth nitrate were treated in the same manner, with the following results:

I. Gave 0·5290 per cent. of bismuth.
II. Gave 0·5267 per cent. of bismuth.
III. Gave 0·5265 per cent. of bismuth.
Average, 0·5274 per cent. of bismuth.

It is recommended in this process not to use starch solution to indicate the end of the titration, as the solution becomes instantly colorless when the reaction is finished.

I found, however, that at times the solution would not become entirely colorless; that a strong yellow tint remained, upon which excess of hyposulphite solution had not the slightest effect. Starch solution was added, therefore, and, when the blue color disappeared, showed the end of the reaction, even if a yellow color remained.

Résumé:

a. 0·5280 per cent. Bi.
b. 0·5270 per cent. Bi.
c. 0·5271 per cent. Bi.
d. 0·5265 per cent. Bi.
e. 0·5276 per cent. Bi.
f. 0·5254 per cent. Bi.
g. 0·5169 per cent. Bi.
h. 0·5274 per cent. Bi.

It will be seen by a comparison of the above that the different methods give nearly identical results, with the exception of *g* (determination as metal), which gives a much lower percentage than any of the others. This is partially, if not entirely, due to the fact that the filter upon which the chloride of bismuth was dried, previous to its reduction with cyanide of potassium, burned with the bismuth flame. Although carefully executed, all the chloride of bismuth could not be removed from the filter before its incineration. Chloride of bismuth being volatile at a low heat, the loss by this method is thus explained.

THE MICROSCOPE IN CHEMISTRY.

By H. C. SORBY, F.R.S.*

LINES and circles have long been looked at through doubly refracting media, such as Iceland spar, but until lately no one seems to have systematically studied the appearances which present themselves when appropriate objects are observed with a microscope through various crystalline substances. These appearances are quite different, because the object-glass of the microscope collects the diverging rays, and we have new conditions. Dr. Royston Pigott described, in 1876, his refractometer. The principle made use of in this instrument was the increase of the focal length of the object-glass of a microscope caused by looking through media of different refracting power. Dr. Royston Pigott measured this displacement by means of a micrometer screw fixed under the stage in such a manner that it became unsuitable for its ordinary use. The author has succeeded in contriving an arrangement which, while it gives sufficient accuracy of measurement, allows the microscope to be used for general purposes. Practically, the application of this method is very simple. If an object be placed on the stage of a microscope and the fans adjusted accurately, on placing over the object a plate of some highly refracting substance the object will be invisible, and to bring it into focus the body of the microscope must be moved further out. If this distance be "*d*," and the thickness of the plate be T, Royston Pigott has shown that

$$u, \text{ the index of refraction, } = \frac{T}{T-d}.$$

Now, this distance can be measured either by means of a scale and vernier attached to the body of the microscope, or by having the head of the screw which works the fine adjustment graduated. To take an example: Suppose we wish to determine the refractive index of water. A small piece cut from a barometer tube is cemented to a glass slide, and the cell thus formed filled with water; the cell is then covered with a cover-glass (which must be larger than the tube, and the surface of the cover-glass must be parallel with that of the glass slide). Suppose the thickness of water, or

T, = 0·2360 in., while d = 0·0790 in.; then $u = \frac{\cdot2360+0\cdot079}{\cdot2360} =$ 1·335; a second determination gave 1·334.

In order to determine "T" and "*d*" we proceed as follows: First, to get T, we focus to the upper surface (any dust or scratches will do for focusing) of the glass slide, and read off the position of the body of the microscope, then focus to the under surface of the cover-glass and read off; the difference between these two readings evidently gives us the thickness of the stratum of liquid, *i.e.*, T. Secondly, to obtain "*d*," the image of a grating or circle is formed under the cell by means of a condenser under the stage, and the microscope focused to it; the cover-glass cell and slide are now placed on the stage so that the observer looks through the cover-glass and slide but not through the cell; the image is again focused; the difference between this reading and the first gives the displacement due to the slide and cover-glass. The cell is now pushed over the image and the latter focused; the difference between this reading and the second gives the displacement due to the stratum of liquid, *i.e.*, "*d*." A ½-inch objective and No. 2 eye-piece are usually employed to obtain accurate measurements. Many precautions are necessary, but, with care, "T" and "*d*" can be determined to $\frac{1}{1000}$th of an inch. Red light is employed. For small quantities of liquid the ordinary live box is not convenient. The author has determined the refractive index of water with a film $\frac{1}{10}$th of an inch in thickness, and obtained the number 1·338. In a similar way the refractive indices of solids can be determined, the only conditions being that suitable slices be cut, which are transparent more or less, and whose surfaces are flat and parallel. If we look at the image of a grating, *i.e.*, two systems of lines at right angles to each other, through a plate with flat parallel surfaces of glass, or any transparent mineral which has no double refraction, both systems of lines are seen at once. The image thus formed is said to be unifocal, and the index of refraction thus determined is that of an ordinary ray. If, however, the mineral possesses d ble refraction, the phenomena presented may be totally different; the ordinary ray has the same properties, and is strictly unifocal; but the characters of the extraordinary ray differ according as the section is cut, perpendicular, oblique, or parallel to the principal axis. Let us take calcite as an example: If we examine the image of the grating through a section parallel to the axis when the extraordinary ray is alone transmitted, the ordinary ray being cut off by a Nicol's prism, it will be found that there are two points separated from one another by an interval somewhat more than ¼ of the thickness of the section, at each of which only one system of lines can be seen at once, *i.e.*, at one focus only the lines, say, from right to left are visible, at the other only those from top to bottom can be distinguished. The image is thus truly bifocal. If we examine a circular hole, furnished by an iris diaphragm, through a unifocal and a bifocal crystal respectively, in the first case the image is seen undistorted and well defined at one focus, whereas in the bifocal image there is no focal point at which the hole can be seen of its true size and shape; it is either drawn out into a long vertical band with curved ends, or a horizontal band, or forms a large circle without any definition. Crystals like aragonite, which have two optic axes, have no ordinary ray and no permanently unifocal images, but two bifocal images. With such a crystal a circular hole is drawn out into crosses. The lecturer then showed in what direction such crystals must be cut in order to obtain their true indices of refraction. The forms taken by gratings and circles were illustrated by models, and by means of the latter it was demonstrated how it was possible to tell at a glance in what direction a mineral had been cut in order to furnish the section under observation. The lecturer then proceeded to explain the application of this method of observation to rock section, and showed how valuable and simple the process was for identifying minerals. Even with sections $\frac{1}{500}$th inch in thickness and $\frac{1}{100}$th diameter, good results have been obtained. The sections must be flat and have parallel sides; they can be examined loose or mounted in Canada balsam, the method of observation being very similar to that described above, in the case of liquids. * * Thus, in the meteoric irons of Krasnojarsk and Rittersgrün, a clear mineral was proved to be Olwine, and the three indices were found to be:

Krasnojarsk	1·71	1·68	1·68
Rittersgrün	1·70	1·68	1·66
Olwine	1·70	1·68	1·66

In some cases it is better to compare the index of refraction of the unknown mineral with that of a known mineral, *e.g.*, quartz, which is lying close to it. With very black hornblendes good results can be obtained by using very thin sections, although the mineral is, in moderately thin sections, quite opaque. As an instance of the marvelously delicate nature of the method, the lecturer gave the examination of a section of a dolerite from near Glasgow, $\frac{1}{500}$th of an inch thick. In this extremely thin section a zeolite, probably analcime, labradorite, calcite and augite were identified with almost absolute certainty. In a similar way, in sections of shells of *Pinna*, $\frac{1}{1000}$th of an inch thick, calcite was recognized, while in a section of the shell of *Naliotis tuberculata*, arragonite was identified. In conclusion, the lecturer referred to the connection between the indices of refraction and chemical composition. The subject is beset with difficulties principally from defective data, but some points come out clearly. The fluorides have low indices of refraction, all the zeolites have indices less than that of quartz. All the earthy carbonates, sulphates and birates have indices between those of quartz and corundum. All minerals with an index greater than that of corundum are metallic or metalloidal sulphur, and sulphides have indices above 2·000 and the arsenides above 2·500. A mineral containing calcium instead of the alkalies has a higher index, *e.g.*, adularia, 1·52; labradorite, 1·61. Again, a mineral containing iron has a higher index than one in which calcium is substituted for that metal. Thus, in the lime garnet, u = 1·74; in the precious garnet, u = 1·79. The lecturer finished by stating that much information might be obtained in a very short time by a qualitative examination of a mineral, *e.g.*, whether it was unifocal or bifocal, etc.

* Lecture delivered to the Chemical Society, April 4th, 1878.

SOLUBILITY OF MAGNESIA, BARYTA, AND SULPHATE OF LIME IN SOLUTION OF SUGAR.—H. PELLET.—Magnesia is not quite insoluble in saccharine liquids; baryta is more soluble than in water. At ordinary pressure the solubility of calcium sulphate in water is little affected by the pressure of sugar.

SULPHUR MINES.

THE *Teinturier Pratique*, at the commencement of an article on the manufacture of sulphuric acid, gives a notice of some of the principal sulphur beds in the world.

In France sulphur is only got in one mine near Apt, in Vaucluse, where the deposit is neither very extensive nor very thick. The mineral raised, a marly limestone, does not contain more than 25 per cent. of sulphur. In central Italy, near Bologna, a vein of sulphur is worked which extends over 25 kilometers in length. The ore is poor and has to be raised from a considerable depth. Almost the whole of the produce is used in sulphuring the vines.

The deposits near Rome have more scientific interest than technological importance. In Austria there are two mines of sulphur worked, one not far from Cracow and the other at Radoboi in Croatia. Both deposits are of considerable extent, but the annual yield is insignificant.

In Spain, in the province of Murcia and at other places, the existence of fine beds of sulphur has been ascertained. Two only are worked, and that not energetically. The quality is very good.

In Tripoli there is a deposit of sulphur important both for its extent and richness, but it is not worked. The same may be said of the sulphur beds along the Red Sea, near the Isthmus of Suez. They rank among the finest deposits in the world, but the want of water is a great obstacle to their utilization.

The author then passes to a description of the Sicilian mines, quite overlooking those of Iceland, which are probably ten times as rich, and which lie so much more convenient for British commerce.

An important improvement in the manufacture of sulphuric acid has been effected at Bordeaux. M. Fournet, by causing the gases from the kilns to circulate more than once in tubes fitted with coke so as to produce a homogeneous mixture, has succeeded with chamber room not exceeding 400 cubic yards in burning an average of 1,000 lbs. of sulphur, obtaining 3,000 lbs. of monohydrated acid (D. O. V.), which is almost equal to the theoretical yield.

MANUFACTURE OF ANTHRAQUINONE.

THE addition of oxidizing agents during the fusion of anthraquinone converts the sulphites generated into sulphates, and prevents the further reduction of the former sulphides which produce non-tinctorial hydro-compounds. At the same time the troublesome evolution of sulphurous acid on the subsequent addition of muriatic acid is avoided. The chrome residues from the manufacture of anthraquinone are partly utilized as chrome-alum and partly reconverted into chromic acid.

Chrome-alum may be directly converted in the cold into chromate of lead so as to produce any desired shade, yellow, orange, or red. Chloride of lime is the most suitable oxidizing agent for this purpose. Ten parts of chrome-alum ground up with 6 parts of the finest litharge, and put into 30 parts of water along with 5 parts chloride of lime—in half an hour the color is ready to be washed and dried. Ten parts of chrome-alum, 2½ hydrate of lime, 5 of litharge, and 5 chloride of lime after standing for some hours yield a fine garnet red. The yield exceeds the theoretical amount because sulphate of lead is mixed with the product. The working cost is small, and instead of chrome-alum even the crude solutions may be used. The cost of manufacture is as follows for 220 lbs.:

340 lbs.	chrome-alum	£1	17
206 "	litharge	2	10
171 "	chloride of lime	1	3
		£5	10

while the sale price for the same quality (?) ranges from £11 to £12. Where chrome residues occur as a waste product this is a profitable method for their utilization.—*Industrie Blatter und Zeitschrift f. d. Chem. Grossgers.*

COLORS FROM IRON TURNINGS AND FILINGS.

By R. and C. STEINAN.

THE object of this invention is to yield a product which shall be equal both in quality and in price to "English red," and to the native ocher obtained by mining in France. The first step is to prepare pure oxide of iron without the aid of acids, and by the simple action of water and atmospheric oxygen, in order to keep within the limits of price. As raw material the inventors prefer wrought-iron turnings, which expose the largest possible surface to air and water, and, by reason of their structure, allow a free passage to both.

In order to obtain peroxide free from protoxide, a so-called oxidizing chest is employed, consisting of two compartments communicating with each other and with water. In one compartment the iron borings lie upon a grating, while the other contains a movable piston. When the piston is at its lowest point the turnings are covered with water, from which they are free when it is drawn up. The piston imparts its motion to the water, forcing it through the iron when going down, and sucking it out when re-ascending. Simultaneously, the air rushes into the empty space, and exerts an oxidizing action, while the hydrated oxide, as fast as formed, is rinsed away from the iron by the descending water. After the piston has been kept in incessant action for twelve hours it is brought to a standstill, in order that the hydrated oxide may collect at the bottom of the chest. By opening a valve it is then drawn off into a conical receiver, placed beneath the oxidation chest, which is then charged with fresh water, and the process is resumed as above. The conical receiver has several depressions, in which impurities are supposed to collect. The hydrated oxide is freed from water by means of a filter press; the press cakes are dried in a drying room, and are then ready for the preparation of colors. In 24 hours the iron yields about 1½ per cent. of hydrated oxide. (A ton of borings thus treated for an entire week would yield, say, 2 cwt. of the product.)

The hydrated oxide of iron can be used directly for the preparation of a yellow, while for a red it must be previously converted into the anhydrous oxide by calcination in a furnace, but without direct exposure to the fuel or the products of combustion. Black is obtained by heating the hydrated oxide with exclusion of air, and in presence of reducing agents, such as carbon or sulphur. Brown and its modifications are formed either by partial reduction, or by mixing yellow, red and black. The inventors afterward mix chalk with the colors to bring them into a marketable state.

[*Quære:* How would a hydrated peroxide of iron thus prepared be suitable for the preparation of pernitrate and persulphate of iron, for the use of dyers and printers, the oxidation not being obtained at the expense of the acid employed? *Quære* further: Whether white lead might not be advantageously prepared by a modification of this process?—Ed. *Chem. Review.*]

ON THE DENATURATION OF ALCOHOL.

UNDER this strange title is hidden a subject of great importance to the chemical arts and manufactures, and which is now attracting much attention in various parts of the Continent. Not only our own Government, but the authorities in several other countries, find it necessary to allow alcohol to be purchased for industrial purposes without the increase of price attached to it when intended as a beverage, both for fiscal reasons and in the interest of public health and morality. In England, as is well known, alcohol which is to be sold duty free for industrial purposes is mixed with ten per cent. of methylic alcohol (pyroxylic spirit and naphtha or wood-spirit), and the mixture is then known as "methylated spirits." But the wood-spirit itself appears liable to duty if only sufficiently purified, and it is very difficult for manufacturers and for scientific men to learn what is the quality which the Government will allow to be used for rendering alcohol undrinkable. The question was once put to the revenue authorities, what was the nature and what were the characters of a wood-spirit which might be imported free of duty? To this very reasonable inquiry, put for the guidance of the memorialists in important business transactions, the reply was what no one would assuredly ever have deemed possible:

"It is not in the power of the Board to define by any specific test naphtha which would be admissible free of duty as crude naphtha, while it is admittedly in the power of the manufacturer of the article to purify it sufficiently to render it liable to duty under the provisions of the law."

We cannot help here asking who on earth, in these days, save the revenue authorities, ever dreams of applying the word "naphtha" to methylic alcohol?

But with the addition of 10 per cent. of wood-spirit, which must be in some state and of some particular degree of purity, which nobody can or will define, the law is not yet contented. It is assumed that all or the most of the alcohol required for industrial purposes "might, could, would, or should" be used by the varnish makers, and, therefore, unless the consumer can give a bond for a heavy sum—if we remember rightly, £1,000—not to use or sell the liquid as a beverage, the further addition of a quantity of shellac is insisted on. It would scarcely be possible to devise an addition more detrimental to the object of the dyer, the color-maker, the manufacturer of extracts of vegetable matters, etc. We cannot, therefore, deny ourselves the mischievous pleasure of pointing out that by the addition of water the shellac is precipitated, and may then be removed by filtration, and those whose tastes are that way inclined may then drink the mixture. We fear, indeed, that no addition not containing a prompt and powerful poison would prevent people from drinking anything having the smell of spirits. A Russian popular proverb says, "There is no such a thing as bad spirits." Certainly, those who will drink absinthe may be safely trusted to drink anything, however nauseous or gradually injurious. It is suggested that the ingredients used for mixing with alcohol should vary according to the use for which it is intended. If it is destined to be consumed in varnish-making, shellac may, of course, do very well. But if it is to be used in the tinctorial arts, or in any of their accessories, something of a totally different nature is needed. Is it impossible to find some substance which, without altering the solvent power of the spirit, or its behavior toward colors, shall impart to it a loathsome smell or taste?

Cheap alcohol is one of the requisites of modern manufacturing chemistry as far as organic substances are concerned, and the want of it, or the tedious and harassing formalities under which alone it can be now procured, is one cause of our failure in competing with Germany in certain important branches.—*Chemical Review.*

SPROUTING OF SILVER AND ITS CAUSE.

By THEODORE FLUEGGER, Assayer St. Louis Smelting Works.

ASSAYERS and chemists all know that great care must be taken with the molten silver, obtained in assaying for fineness and quantitative determination of same in ores and furnace products, to prevent what is generally termed sprouting of the silver, which is nothing else but a disengagement of oxygen gas, absorbed by the silver while in a highly heated state, giving rise to the peculiar arborescent appearance observed on the surfaces of silver after sprouting, and endangering thereby a loss of silver. In order to obtain a reliable assay, the greatest caution is therefore necessary to prevent the sprouting, the cause of which is not generally known; but to prove that it is due to the disengagement of oxygen after the act of solidification, and not to the contraction of the outer, cooler layers, as some theorists contend, on the inner mass of metal, any one can convince himself by the following small experiment, which will, no doubt, interest many who have witnessed this remarkable behavior of the silver: 50 grammes of pure silver may be taken and placed in a common scorifier with 10 grammes of borax glass, and heated in a muffle to a white heat (over 1,000° C.) for at least half an hour. The experiment will often fail if heated in less time than above stated. After the expiration of the half hour the scorifier, with contents, can be taken out of the muffle, and placed on a brick or some other cool object. The silver can soon be seen to solidify through the clear borax glass which covers it, but the disengagement of the oxygen will not take place immediately after solidification, and varies with the degree of heat and other prevailing circumstances. Blowing and disturbing the scorifier must be avoided. The oxygen will gradually show itself by raising the soft and expansible borax glass, forming in successful experiments a large bubble about the size of a walnut. The borax glass solidifies in the shape of a small hemisphere, which contains the oxygen. The usual tests for oxygen may now be applied. A match is charred and allowed to glow, the glowing end is suddenly thrust through the thin side of the hemisphere of borax glass, breaking it and exposing to the oxygen the glowing end of the match, which will immediately burst with a bright flare into a flame, proving the presence of either oxygen or nitrous oxide gas. Binoxide of nitrogen will give the final proof of producing red flames, which are conclusive that oxygen and not nitrous oxide gas is present. To this end several of the bubbles obtained on the scorifiers in the above way were burst under water, the escaping gas allowed to ascend into a receiver, and then the binoxide of nitrogen introduced by means of a tube, connected with the generating apparatus, containing copper and dilute nitric acid. This neat experiment was first made and successfully repeated in the laboratory of the St. Louis Smelting and Refining Company.—*Engineering and Mining Journal.*

DETECTION OF COPPER.—Copper, where it is not wanted, is a very unwelcome guest, capable of doing much mischief. Its presence in liquids and soluble solids may be easily detected by the following method: Into the dilute liquid we plunge a galvanic couple, consisting of a wire of zinc and one of platinum soldered together at one end. If copper is present, it forms a blackish deposit upon the platinum. If this deposit is washed but not dried, and exposed to the fumes given off on pouring sulphuric acid upon bromide of potassium, it takes a deep violet color, which is best seen on rubbing the platinum wire upon a plate of porcelain. If the wires are left in the solution suspected for 12 hours, one part of copper can be thus detected in a million of other substances.—M. L. CRESTI, *in Deutsche Chem. Gesell.*

CHROME BLUE.—M. GASTON BONG.—The following materials are intimately mixed and strongly calcined with free access of air:

Boric acid	15 parts.
Alumina	15 "
Carbonate of magnesia	20 "
Chromate of baryta	2 "

THE fruits of the Cascalote (*Caesalpinia Cacalaco*) and the Huisache (*Acacia Albicans*) are both rich in tannin, and are used in Mexico in place of gall-nuts. Their percentage of tannin has not yet been determined. Their value on the spot is about 1¼d. per pound.

THE NATURE, ORIGIN, AND PROGRESS OF DISEASE IN THE HUMAN BODY.

By J. B. GRAVES, M. D., Corning, N. Y.

THE manner in which we propose to investigate this subject will make it necessary for us to consider the composition of the body itself. The body is composed of atoms, and these atoms are arranged according to fixed and established laws, laws that cannot be changed. They can no more be changed than the Almighty who established them can change. These laws are: First, the law of origin. Second, the law of growth or development. Third, the law of waste and repair.

The different parts of the human body are formed by some combination of atoms. The manner in which these atoms are combined determines the nature of the formation. The combination of atoms forms molecules, and molecules combined form cells; the cells thus formed are proliferated into tissue. A certain arrangement of these tissues forms an organ, and a certain arrangement of these organs thus formed constitutes the human body.

There are three different states of matter known to us, namely, solid, fluid, and gaseous. We find matter in these different states in the human body. This may be called the molecular condition of the body. Before proceeding with our inquiry, we must understand what is meant by atom, molecule, and cell. We do not use the terms atom and molecule as synonyms in this discussion. An atom is a unit. It is indivisible matter, whether solid, fluid, or gaseous. By molecule we mean some combination of atoms. To illustrate our position we will take alcohol. Alcohol is a compound made up of atoms of carbon, hydrogen, and oxygen in certain proportions—twenty-four atoms of carbon, six of hydrogen, and sixteen of oxygen. When thus united they make alcohol. No other combination of these atoms will produce alcohol.

Another illustration: Water is a compound substance made up of hydrogen and oxygen in certain proportions—two of hydrogen and sixteen of oxygen. The magnitude which we call a molecule of water consists of two magnitudes, which we call atoms of hydrogen and oxygen. The relations in which atoms stand to each other are far-reaching and intricate, and cannot be accidental.

The elementary atoms of which the body is composed have a certain number of bonds by which they are united. And by these alone can they be united for a specific purpose. The manner in which the atoms are grouped together in the molecule is important for us to understand in the prosecution of our inquiries on the subject. Every molecule is a unit in which all the atoms are joined together by their several bonds; and it becomes an object of great interest to investigate and determine the exact manner in which the molecular structure is built up. To understand the diseases of the body we must study the structure; and in order to study its structure, we must understand the structure of its molecules, as well as the atoms of which the molecule is composed. Certain atoms are united according to fixed and established laws, and when thus united they make a molecule, as in the formation of alcohol or water. Molecules thus formed, when combined in a certain manner, according to these laws, form what is called a cell. We are now speaking of normal action. The nature of the cell is determined by its composition. The cell thus formed is proliferated into tissue, and it is by this process that the different organs of the body are built up.

Now, when we come to consider what constitutes disease of the body thus formed, we are led at once to the conclusion that there must be some disturbing force that has changed the operation of these laws. This, then, brings us to the definition of disease, and we shall not define by enumerating symptoms. But we will define disease of the human body, at all times and under all circumstances, to consist in atoms out of place.

The atoms of which the body is composed cannot be changed in their nature. They are the same in substance and in nature at all times and under all circumstances. Yet an atom out of place must break down and destroy the molecule. Take a molecule of alcohol and abstract an atom of oxygen therefrom, and you will no longer have alcohol. An atom is out of place, and that destroys the molecule. The change of a molecule of a cell must result in a change of the nature of the cell, and the cell thus changed cannot be proliferated into normal tissue. Its very nature is changed; yet the laws by which it was formed are not changed. The atom is the same, and the laws that govern atoms are the same.

There is another law that steps in here and controls. It is the law of waste, or, perhaps, of decadence, I should say. The moment a molecule is changed it produces a change in the cell of which it is a part, and that cell may form a degenerated tissue, a cancer, if you please. It must continue to degenerate until it is resolved into its original atoms; and they are indivisible and indestructible. The atoms of which the molecule is composed, and the molecules of which the cell is composed, are not thrown together promiscuously, but are united by certain bonds, and the microscope reveals the fact that the atoms of which the molecule is composed are continually in motion in every

conceivable direction and manner. Now, there is some force that operates to produce this motion or action. The life of the molecule must be determined by the motion of the atoms of which it is composed. The life of the cell must be determined by the character of the molecules of which it is composed. A change of an atom must change the character of the molecule, and a change of a molecule must change the character of the cell; and when the cell is changed thus, you have an abnormal state or condition of the part, and that is what constitutes disease of the organism. This must in all cases, at first, be local. It must commence in the molecule. Some disturbing force changes the atom of the molecule. Or some disturbing force disturbs the molecule of which the cell is composed, and it cannot now be proliferated into normal tissue. The changes that are produced in the system are isomeric. These changes do not produce germs. There is such a thing as a diseased germ. The change of a single atom of a germ would produce a diseased germ; but that diseased germ could not produce a normal germ or tissue. A kernel of rye is a germ, and when it is placed in a proper position and surrounded by proper influences, will reproduce itself. Yet an isomeric change will make it produce ergot, and the ergot will not reproduce itself, nor will it produce the rye. It is an entirely different substance from the original from which it sprang.

Let me illustrate this subject by a reference to the cow-pox and small-pox. These diseases change the system, so that the virus of small-pox will produce no effect upon the organism. The change is isomeric. There is no change of the atoms of the molecule. There is no change of the molecule of the cell. The body grows and changes as before. The offspring of parents who have been vaccinated, or who have had the small-pox, are not protected thereby from small-pox. They must be vaccinated to be protected. The peculiar state of the organism produced by the cow-pox, or by small-pox, is not transmissible to posterity.

The germ that produces the new being does not partake of the change that has been produced in the organism of the parents by either of the above-named diseases. And let me ask here, how is it possible that any disease can be transmitted by natural generation? The laws by which the body is built up are hid from our vision. Certain things with regard to them we can understand: the formation of cells and the proliferation of cells into tissue; also the perversion of a cell by a disturbing force, so that it shall form an abnormal tissue. These facts lead us, in our inquiries, at once to consider the constitution of matter. Here we find a principle of energy and motion. We also find a differentiation and harmony. "This principle, whatever it may be, is called spirit. Spirit, then, is not substance, but it is the law of substance; it is not force, but it is the revealer of force; it is not life, but it makes life exist; it is not thought, but it is the consciousness of thought" (Maudsley, Virchow). Carpenter says, "Spirit is the sole and single source of power." Spirit, then, is not a property of matter, but matter is a property of spirit. The materialists stop short at atoms, and localize those properties for which atoms supply no cause.

The source of differentiation, harmony, and force cannot be in energy itself. It must be in a principle apart from that energy. In our investigation of the origin of disease in the human body, we must keep in view the above principles. There have been volumes written to prove that certain diseases are transmitted by parents to their posterity. This doctrine we do not believe. It has never been established by proof, and, if our views are correct, it never will be established. Let us consider the ovum for a few moments, with the above principles before us. The ovum is a cell of peculiar construction, in accordance with fixed and established laws of the human organism. This cell is composed of molecules, and these molecules are composed of atoms. In this cell there is harmony, motion, and differentiation. The action that is here set up, if undisturbed, will develop the new being. A disturbing force prevents the development of the new being, and would prevent the formation of the nucleus of the new organism. The law of reproduction and of decadence cannot act in harmony with the same atom. All the atoms of the ovum are necessary to the development of the nucleus and the new being. A mixture of normal and abnormal molecules cannot form a normal cell. The ovum commences by the union of two or more atoms. This union is according to established laws. The atoms are indivisible and indestructible. This union makes a molecule, and the union of molecules makes the cell. Now, take twenty-four atoms of carbon, and six of hydrogen, and fifteen of oxygen, and one of nitrogen, and unite them, and you will not have alcohol. The nitrogen is a disturbing force, and will prevent the formation of alcohol. So the virus of small-pox or syphilis, or of any contagious disease, must be something; it must be more than an atom. It must be some union of two or more atoms of different substances. However it is constructed, it is, in its nature, a disturbing force, and must prevent the union and action of molecules in the formation of the ovum. After the nucleus is formed, and the new organism is developed so as to receive pabulum from without, a disturbing force may be introduced, and a certain portion or part of the new organism may be destroyed or changed. Disease may thus be set up and run rampant, riot and feed upon the new formation, until it finally destroys it. There are now a multitude of cells to destroy; at the commencement there was but a single cell. Strictly speaking, then, there is no such thing as functional disease. All diseases must begin by some atomic change. Functional derangement is only a symptom of disease. The changes that produce what we call disease are isomeric. 1. According to the views presented in this paper, the popular doctrine of germinal origin of disease is not well founded. 2. All diseases of the human body are organic. 3. Disease is not and cannot be propagated by natural generation. There is, unquestionably, a peculiarity of organism transmitted from parent to child that predisposes to certain diseases. This is very different from propagating disease itself. 4. Much of the present manner of administering to remove disease is worse than doing nothing.—*Medical and Surgical Reporter.*

THE EAR.

Now and then you will notice that in certain cases you may acquire, quite suddenly, a reputation for relieving deafness, by simply syringing the ear and removing a mass of impacted cerumen. This form of deafness results from an accumulation of cerumen, the cause of which comes from the habit of passing the end of a towel, brush, or "aurilave" into the external auditory canal in washing the ear, and so gradually pressing the cerumen into a compact mass, which fills up the canal. The canal may be full in its upper part and the patient able to hear well, but suddenly there comes a very hot day and sweat runs into the meatus, or the patient takes a hot or a sea bath, or somehow water gains an entrance alongside of and soaks the mass, and gradually or suddenly the cerumen swells and falls into and presses upon the membrana tympani. This pressure on the membrane, besides causing deafness, extends through the ossicles to the stapes and oval window, and causes tinnitus and buzzing noises, pain, giddiness, confusion of ideas, with a feeling of weight and pressure in the labyrinth from the endolymph being compressed, and its reacting upon the auditory nerve. If this pressure is relieved by removing the mass by syringing or by other means, as if by magic relief is afforded, and the patient is full of gratitude; and if this mass has not remained long enough to produce a permanent change, as in chronic cases, the membrane assumes its natural curvature, no longer remaining depressed, and the ear regains its healthy condition. If this should happen in more than one case in succession, the medical man is of the opinion that all cases of deafness are to be relieved in a similar manner, and both he and his patient are convinced that he has acquired the secret of curing a most troublesome malady; the patient often acts as a disciple of the doctor, and will go about informing every deaf person he meets of the wonderful success of his physician. And then there comes another class of cases, which is termed chronic. These cases may have visited every aural surgeon for relief, or perhaps the patient comes for the first time; the physician examines his new case and finds what looks very much like the old trouble; he goes to work and carefully removes what seems to him a mass of cerumen, but after numerous syringings he no longer removes a plug of dark brown cerumen, but only a mass of large flakes of what the older writers called epidermis, and what is now known to be more properly epithelium. This epithelium or pavement-like covering of the skin of the ear in most healthy individuals is removed by a natural process, just as it passes off from the skin of the rest of the body when friction is employed, and can be seen, as when in the sunlight we rub the surface of the skin, and these flakes float in the air. If, however, moisture from any source finds its way into the ear, they no longer pass out, but become massed together with particles of cerumen, and even form tumors (cholesteatomata) which may perforate the membrana tympani, as in one of the cases I am about to show you.

Colonel O., aged 50; general health good; most of his family have suffered from gout. His ears have been giving him some uneasiness, and he is troubled with deafness; once in a few months there would form and escape a complete globe-like cast of the auditory canal, now and then tinged brown with cerumen or red with blood. While the mass was becoming loose he suffered from distressing noises and pain, but after its removal by syringing, and the subsequent use of astringent and alterant washes, he would be free for several months. His hearing is more or less impaired. This is an example of the ordinary mild form of this disease.

Thomas M., aged 32; by occupation a collector; resides in Philadelphia; both father and mother are living and are not deaf; their general health is good. The patient suffers from deafness and distress in both ears; the disease commenced first in the left ear, and subsequently attacked the right, and this has caused him to apply, for fear of losing the hearing in that ear. He knows of no cause, except that he has been told he was scrofulous, or that he is frequently exposed to the weather by reason of his out-door occupation. He has at times intense itching in the external auditory canal, with a constant humming noise and throbbing, with pain, and a confused feeling in the head, and now and then a chill following these irritable attacks; occasionally there is a small amount of discharge. He has had no treatment. The disease has been of three years' duration in the left ear and some six months in the right. There is more or less seborrhœa of the scalp, with slight eczema of the eyebrows and skin. On inspecting the auditory canals they were found to be filled with a dirty-white and brownish mass of scales of epithelium, etc., a portion of which was removed with the curette and forceps, which, on microscopic examination, was found to consist of scales of epidermis, cerumen, and cholesterine crystals. There is also a peculiar fetid odor noticeable about the left ear. His hearing in the right ear was seven feet, with a watch heard at twenty-five feet, or about one-third the normal distance, while in the left ear the hearing was reduced to twenty inches. When the material was removed by careful syringing, after having previously softened the mass with a solution of bicarbonate of soda, glycerine, and warm water, there was found an irritable red meatus, and in the left ear the same, with a perforation of the membrana tympani, surrounded by granulations springing from the walls of the canal and passing into the middle ear. This is to be treated by careful syringing and the use of astringent and stimulating washes and a mild ointment to protect the skin of the meatus from the irritation of both moist and dried discharge.—DR. LAWRENCE TURNBULL, Philadelphia.

ANNA MORANDI MANZOLINI, PROFESSOR OF ANATOMY AT THE UNIVERSITY OF BOLOGNA.

By MADAME VILLARI.

THE art of making anatomical preparations in wax was first discovered toward the end of the seventeenth century. Some writers ascribe the honor of the invention to G. Desnoves, by birth a Frenchman, Professor of Anatomy at Genoa; others, and we think with more reason, to a certain Gaetano Giulio Zumbo, a gentleman of Syracuse. It is true that the latter worked with Desnoves at Genoa, but we read in an essay on the Florentine Galleries, by Pelli Bencivenenini, that Zumbo was so celebrated for his profound anatomical knowledge and skill in making wax preparations, that, some years before we hear of him in Genoa in connection with Desnoves, he was employed in Florence at a high salary by the Grand Duke Cosmo III.

One of his principal works consisted in a series of small figures, colored from life, representing the human body in every stage of corruption. There is still to be seen in the Specola Museum, in Florence, a head partly dissected so as to show the different organs, similar to that he afterward made in Genoa and exhibited in Paris, and of which Professor Desnoves claimed the invention, asserting that Zumbo had only worked under his direction.

Some fifty years later there flourished in Bologna a famous anatomist named Ercole Lelli,* who devoted much attention to this branch of art, and who, in 1742, aided by the liberality of Pope Benedict XIV., began his six years' task of constructing a complete collection of anatomical models, of which a portion still exists in the Bolognese Institute.

Requiring skilled assistance in this work, he employed a certain Giovanni Manzolini, a good anatomist, expert draughtsman, and painter, and who possessed, too, the secret of mixing certain ingredients in his wax that gave it greater consistency and firmness. Now this Manzolini, a nervous, despondent man, full of hypochondriacal fancies, had taken to wife some ten years before a bright, clever young girl of great artistic promise, named Anna Morandi, who had long proved herself the best and most energetic of helpmeets. Thus it fell out that when Lelli began to employ Manzolini on his great anatomical work, Anna, desirous to spur on her weak-minded, indolent husband, so dependent on her in every way, applied her abilities also to modeling in wax, and profited so well by her husband's instructions that she materially aided him in all the lighter portions of the work, and surpassed him in delicacy of detail.

After three years, when already one-half of the great collection was completed to Lelli's entire satisfaction, poor, foolish Manzolini determined to throw up the unfinished work, having taken the idea into his weak head that Ercole Lelli intended to keep his (Manzolini's) name in the background, and appropriate to himself all the honor, glory, and profits of the undertaking.

There does not seem to have been the slightest foundation for this fear, since Lelli frankly acknowledged that he could not have completed the work without the aid of Manzolini's talents; but the latter was one of those hypochondriacal, weak, and narrow men who always consider themselves the victims of deep-laid conspiracies, while moaning out his wrongs to all who would listen to him. He does not seem to have even had the straightforwardness to ask Lelli to increase his remuneration. Luckily for him, he had a tower of strength in his wife. It is strange how often one sees a gifted, high-spirited woman pouring out the treasure of her affection on some weak, shiftless man.

When, therefore, Manzolini parted from Lelli and began to work at his own house, Anna quickly perceived, by the way in which he wasted his time in lamenting his hard fate, and the envy (apparently imaginary) that condemned him to obscurity, that there was small chance of the anatomical preparations he had undertaken being finished by the appointed time.

So, having much at heart the honor and interest of her pusillanimous husband, she determined to apply herself seriously to the study of anatomy, instead of confining herself merely to the execution of the details in wax. At first she experienced great difficulty in conquering her natural repugnance for the revolting work of dissection, and we learn that her physical sufferings were great; nevertheless "love cast out fear," and she steadily persevered in the task until she not only became a first-rate practical anatomist, but made various original discoveries.

Manzolini was well content to encourage her in her difficult enterprise, and, grateful for this proof of her affection (since, with all his faults, he seems to have heartily loved and appreciated his gifted wife), aided her by his own knowledge and experience, and made her study all the best works on anatomy. Very soon, then, we find her skillfully exercising her scalpel by her husband's side, and able to give scientific explanations of the preparations they worked upon together.

Meanwhile a physician of high standing, named Galli, had opened in his own house a school of obstetric science for surgeons and midwives, and for their better instruction confided to Anna Manzolini the execution of a series of wax models of infants in every stage of gestation. Having completed this task in a masterly manner, Anna now began to give anatomical lectures herself. In these, besides imparting the knowledge acquired from her husband, she communicated many discoveries she had herself made in the course of her studies, and which had hitherto escaped the attention of the most experienced anatomists of that day. Anna showed peculiar skill in all dissecting experiments requiring great minuteness and delicacy, and demonstrated, both theoretically and practically, the wonderful structure of the human body, and the exact formation and position of the bones, nerves, and ligaments of different animals.

By the novelty of her method of demonstrating these truths, and her rare excellence in dissection, Anna's name became celebrated throughout Europe, and no traveler of any distinction in science or learning passed through Bologna without seeking her acquaintance or attending her lectures. Not a few of these travelers have rendered eloquent testimony to the extent and depth of her acquirements.

In the year 1755 Anna's domestic happiness was shattered by the death of the man she so tenderly loved. Despite his weakness of character, Manzolini seems to have been a good and affectionate husband, and it is certain that his wife was devotedly attached to him. In all time it has been a common spectacle to see energetic, high-souled women lavishing their love on men in every respect their inferiors.

Anna's grief, however, did not distract her from her profession, to which she devoted herself with unremitted zeal. Honors of all kinds were showered upon her. In the first year of her widowhood she was elected a member of the Scientific Institute of her native city, of the Clementine Academy in 1758, of the Literary Society of Foligno in 1760, and of the Florentine Academy of Design in 1761. All these distinctions, however, were barren of material advantages, and Anna's means were of the narrowest. It is true that the Bolognese Senate had, soon after Manzolini's death, conferred upon her the chair of anatomy, but this professorship was only worth 300 francs per annum (less than £12), and she had two little boys dependent on her exertions. All writers testify to the purity of her life, and record with what jealous care the still handsome and attractive widow preserved an unsullied reputation.

In 1765 it is not astonishing to find her petitioning the Senate to raise her salary to the magnificent sum of 500 francs a year, but it is surprising to read that the Senate not seeing fit to accede to her modest request, she was obliged to accept aid from private individuals.

One Senator, Count Ranuzzi, less niggardly than his colleagues, agreed to grant her a monthly stipend, with board and lodging in his own palace, in exchange for her anatomical collection, library, and instruments. Apparently this bargain was merely a delicate fiction, designed to lighten Anna Morandi's sense of obligation to her benefactor, for we read that her collection and other possessions were carefully arranged in the apartments assigned to her, and that at her death she bequeathed them, with other things, as a legacy to the Institute of Science.

Visitors to Bologna interested in anatomy will find this

* Lelli began life as an arquebuse maker, and his artistic studies, pursued simply with a view to the decoration of arquebuses with arabesques and human figures, led to his becoming a painter, wood-carver, and sculptor, working with equal facility in clay, wax, plaster, wood, and marble, and in all showing singular anatomical skill. The clever wooden statues supporting the canopy of the professor's chair in that cedar-paneled lecture-hall where Galvani immortalized his name will have attracted the attention of all visitors to Bologna. These are Lelli's, and they represent the human body as it appears when stripped of all exterior integuments. While engaged on these figures, Lelli skinned no less than fifty subjects with his own hands, in order to insure precision in every detail; but his scientific ardor well-nigh cost him his life, for the prolonged contact with dead bodies brought on a most dangerous illness.

collection very complete and valuable, and of great artistic merit. Anna Morandi was the first to reproduce in wax such minute portions of the human body as the capillary vessels and the nerves.* Here, too, even with those minutest parts that are barely visible to the naked eye, may be seen accurately reproduced in wax the organs of smell, hearing, touch, sight, and taste. In all these Anna far surpasses the best efforts of the celebrated Ercole Lelli, and of her husband and master, Manzolini. She delivered her lectures in that fragrant cedar hall which is one of the sights of Bologna, and in which Lelli's wonderful anatomical wooden figures supporting the canopy over the professor's chair attract general admiration.

Now and then Anna sought recreation from her graver studies in the execution of purely artistic works in wax; among these is a crucifix with a Magdalen weeping at the foot, and she also took great pleasure in making life-size portraits of her friends, also in wax. At the request of many admirers she modeled excellent portraits of her husband and herself, and these are still to be seen in the Anatomical Gallery of the University of Bologna. She has represented herself, scalpel in hand, in the act of dissecting the human brain.

Our English sculptor Nollekens made a successful bust of Anna Morandi, which is still preserved in the Palazzo Ranuzzi.

It is not a little touching to read that this celebrated woman, who had pleaded in vain for a yearly addition of £8 to her slender pittance, refused many lucrative offers from other cities of Europe, preferring poverty in her beloved Bologna to wealth elsewhere. From London she received repeated and tempting offers. The Empress of Russia invited her to her court, proffering the most munificent and advantageous conditions. Two Italian universities tried to entice her away from Bologna, and from Milan she received a blank agreement, which she was asked to fill up with any terms she liked to name, if she would only consent to exercise her profession in that liberal city.

While returning to all these invitations the unvarying reply that she preferred retaining her Bolognese professorship, she showed her gratitude by forwarding to the respective museums sets of her anatomical preparations in wax, accompanied by full explanations.

So, poor and honored and hard-working, Anna continued her labors until her death, in 1774, at the age of sixty-eight, leaving two sons, who did not seem to have inherited any portion of their parents' talent.

Anna Morandi Manzolini was buried in the Church of St. Proculus, where a lengthy Latin inscription marks her grave and testifies to her well-earned fame.—*International Review.*

FACTS ABOUT SLEEP.

WITHOUT a full proportion of sound and regular sleep, the mind sooner or later fails of its elasticity, its vigor, and its life, to be followed by nervousness, weakness of intellect, softening of the brain, insanity, and death. The varying amount of sleep required in individual cases, and at different times, renders it impossible to make any fixed rules upon the subject, and each observant individual will soon learn the requirements of his own system. Alfred of England divided the day into three portions of eight hours each, one of which he assigned to sleep. Bishop Taylor considered three hours' and Richard Baxter four hours' sleep sufficient for any man. Frederick of Prussia and Napoleon, as a general thing, devoted only three or four hours to sleep. Individual cases are authenticated of persons reaching advanced age without ever having had more than one or two hours of sleep out of the twenty-four. Wesley states, however, that during his long life he never knew any individual who retained vigorous health for a whole year with a less quantity of sleep than six hours out of the twenty-four.

No one measure of sleep will answer for all, nor will the same amount of sleep suffice even for the same persons at all times. A person debilitated by sickness requires more sleep than one in vigorous health; more is necessary when the strength and spirits are exhausted by hard labor or severe mental efforts. In infancy and youth, where the animal functions are extremely active, the necessity for sleep is greatest; in mature age it is less indulged, while the aged frequently spend a larger proportion of their time in sleep, though in some instances it may be short and light. The average of humanity requires fully seven hours' sleep, and the number who can maintain mental and bodily vigor with a less amount of sleep is far exceeded by those whose systems demand even more than seven hours.

The influence of habit in promoting or preventing sleep is remarkable. Those accustomed to the quiet of rural districts are annoyed by the din of city thoroughfares. Men who are in the habit of sleeping in buildings occupied by noisy machinery awake the moment the wheels and cogs and gears come to a standstill. It is said that those who live near the cataracts of Niagara or of the Nile cannot sleep at a distance from them, owing to their having become accustomed to the roar of waters. Well attested cases are recorded where soldiers would sleep, after extreme fatigue and exhaustion, on the ground by the side of a twenty-four pounder which was being constantly fired. Marines slept from fatigue on board of Nelson's ship at the battle of the Nile. Even boiler-makers have been known to sleep in a boiler while the workmen were constantly hammering. Sleep can continue even with the exercise of certain muscles. Couriers on long journeys nap on horseback, coachmen on their boxes, and in these latter days many travelers sleep soundly in palace cars or sleeping coaches. Among the impressive incidents of Sir John Moore's disastrous retreat to Corunna, in Spain, not the least striking is the recorded fact that many of his soldiers steadily pursued their march while fast asleep. It is said by military authorities that this is not uncommon among soldiers. Franklin slept nearly an hour while swimming on his back. Many singular occurrences prove conclusively that sleep is not incompatible with motion.

The lower order of creation obey peculiar laws in regard to sleep. Fish are said to sleep soundly, preferring to retire under the shadow of a rock or a woody bank. Many birds and beasts of prey take their repose in the daytime, though they all seek a certain degree of seclusion and shade, with the exception of the lion, who sleeps at noonday in the open plain. The eagle and the condor will poise upon the most elevated pinnacles of rock, and sleep in the clear blue atmosphere and dazzling sunlight. Of domestic animals, the horse seems to require the least sleep, which he usually takes in an erect posture. Birds that roost in a sitting position are furnished with a well adapted mechanism which keeps them firmly supported without voluntary or conscious action. The tendon of the claws is so arranged as to be tightened by their weight when the thighs are bent, thus contracting closely and grasping the bough or perch. In certain other animals that sleep erect the articulations of the foot and knee are described as resembling the spring of a pocket-knife, which opens the instrument and serves to keep the blade in a line with the handle. All animated nature seems to be dependent upon the recuperative power of sleep.—*Boston Cultivator.*

* Ranieri d'Arpinello, in his "Historical Fragments," does indeed mention a young girl, named Alessandra Gilliani, who, in the early part of the fourteenth century, had discovered a method of cleansing and preparing the nerves and arteries in a miraculous manner, so that they were rendered impervious to decay. She is said to have died at the age of nineteen, from the effects of over-study. No well-known writer, however, authenticates this account.

ANTIPATHIES.

ANTIPATHY is commonly defined to be an involuntary dislike or aversion to an animate or inanimate object, and embraces a class of cases in which individuals are disagreeably affected by things innoxious or agreeable to the majority of mankind. Antipathies are as various as they are unaccountable, and often in appearance ridiculous, yet to those who are influenced by them they are generally natural infirmities or peculiarities, beyond the control and not always the result of fantastical imaginings. Different degrees of antipathy are exhibited, some even amounting to a revulsive feeling, such as the hysterical dread of spiders crawling on the body, dislike of cats, dogs, toads, mice, rattlesnakes, and the like. Most Europeans and Americans have an antipathy for serpents, while inhabitants of Eastern countries experience no such dread.

Nearly all persons have a loathing of reptiles or insects; some are thrown into convulsions by smelling musk or ambergris; several persons are mentioned in history, among them Mary de Medicis, who would faint at the smell of roses. Lusitanus also relates the case of a monk who fainted when he beheld a rose, and never quitted his cell when that flower was blooming. Scaliger mentions one of his relations who experienced a similar horror when seeing a lily. Zimmerman tells of a lady who could not endure the feeling of silk and satin, and who shuddered when touching the velvety skin of a peach. Erasmus, though a native of Rotterdam, had such an aversion to fish that the smell of it threw him into a fever. Ambrose Paré mentions a gentleman who would fall into convulsions at the sight of an eel, while a French lady always fainted on seeing lobsters. Montaigne, in discussing the subject of antipathies, remarked that there were men who dreaded an apple more than a musket ball. Uladislaus, King of Poland, could not bear to see apples, and if that fruit was shown to Chesne, secretary to Francis I., he bled at the nose.

Many individuals take singular dislike to harmless animals. Henry III. of France could never sit in the room with a cat, and the Duke of Schonberg ran out of any chamber into which one entered, while a gentleman in the court of the Emperor Ferdinand would bleed at the nose on hearing the mewing of a cat, however great the distance might be from him. M. de l'Ancre gives an account of a very sensible man who was so terrified at seeing a hedgehog that for two years he imagined his bowels were gnawed by such an animal; the same author was intimate with a very brave officer who was so terrified at the sight of a mouse that he never dared to look at one unless he had his sword in his hand. Many strong-minded and sensible people, even in our own midst, are thrown into great distress of mind at the sight of a mouse. Tyche Brake shuddered at the sight of a fox; Cæsar trembled at the crowing of a cock; the Duke d'Epernon swooned on beholding a leveret, although a hare did not produce the same effect, while Marshal d'Albert fainted at the sight of a pig. M. Vaughein, a celebrated huntsman in Hanover, would faint outright, or, if he had sufficient time, would run away at the sight of a roast pig. Julia, daughter of Frederick, King of Naples, could not taste meat without serious accident.

A large class of persons have an antipathy to animal food, and from childhood refuse to eat it; in others the aversion is limited to one kind of meat, as veal or pork; others are averse to eggs or milk, while whole families are known to entertain a horror of cheese. Joseph Scaliger and Peter Abono never could drink milk; Cardau was particularly disgusted at the sight of eggs; Boyle records the case of a man who felt a natural abhorrence to honey. Other singular antipathies are vouched for. Lord Bacon fainted at every eclipse of the moon, and Ariosto at the sight of a bath. Hippocrates mentions one Nicanor who swooned whenever he heard a flute, while Shakespeare has alluded to the similar effects of the bagpipe. Boyle fainted when he heard the splashing of water, while John Rol, a gentleman of Alcantra, would swoon on hearing the word *lana* (wool) pronounced, although his cloak was made of wool. La Motte le Vayer could not endure the sound of musical instruments, though he experienced a lively pleasure whenever it thundered. A lady living near Exeter, in England, had a mortal aversion to all colors except green, yellow, or white; she has been known to swoon away at the sight of a soldier, while a funeral never failed to throw her into a violent perspiration. The author of the "Turkish Spy" tells us that he would rather encounter a lion in the deserts of Arabia, provided he had but a sword in his hand, than feel a spider crawling on him in the dark.

No reason can be given for these and numerous other instances of secret dislikes, yet it seems quite certain their manifestations are beyond the control of the individual will. These peculiarities are no doubt sometimes acquired in early life by injudiciously terrifying children with some object, the mental impression becoming permanent. It is uncharitable, in dealing with such persons as are under these uncontrollable influences, to make light of their fears and antipathies, while only pure selfishness can expect every member of the human family to be actuated by similar impulses or regulated by similar self-control.—*Boston Cultivator.*

COST AND NUTRITIVE VALUE OF FOODS.

NEXT to rice, Indian corn is used by a larger number of people than any other grain, while its consumption is increasing rapidly year by year, since it is cheaper than any other grain food in the world. I anticipate, in less than twenty years, the consumption of Indian corn will exceed that of all other known grains. In this connection, and as exhibiting in a comparative way the cost and nutritive value of the foods upon which the people of the world subsist, the following translation of a table recently published by Dr. J. Kœnig, of Germany, who has spent years of careful experimenting upon this and kindred subjects, is of interest. The prices are reduced to our currency.

The principal value of this table to an American is in showing the relative proportion existing between prime cost in Germany and the nutritive value as determined by Dr. Kœnig, illustrating the fact that in many articles of food the first cost is far greater than the real value as food, while in such articles as Indian corn, beans, milk, lungs and liver of beeves, the nutritive value is above that of the cost market value.

Articles of food.	Nutritive value as a standard. Cents.	Market value of same quantities. Cents.
Rice	6·	16·
Indian corn	9·36	2·
Wheat, fine	5·20	8·8
" coarse	6·31	4·5
Rye, fine	6·63	7·2
" coarse	8·42	4·8
Oatmeal	7·33	12·
Hulled barley	6·	7·20
Buckwheat groats	6·61	14·40
Beans	2·46	0·75
Peas	9·74	6·
Potatoes	1·67	1·20
Carrots	0·56	6·60
Cabbage	0·94	2·40
Spinage	1·52	4·40
Asparagus	0·78	3·
Sweet chocolate	7·56	4·30
Milk	6·72	3·
Butter	35·20	45·
Cheese	44·70	35·
Hens' eggs	20·12	44·
Lard	39·10	36·
Medium beef, first cut	27·26	32·
" " second cut	28·78	28·80
" " third cut	26·46	17·20
Extra " first cut	36·58	33·20
" " second cut	34·84	33·
" " third cut	32·38	32·
Lean beef	31·46	34·20
Liver	26·64	10·
Kidneys	22·46	20·
Breast of veal	30·88	34·80
Leg	28·24	39·60
Heart	24·36	12·
Lungs	22·16	6·
Ham of half fat pig	34·42	32·
Ribs	34·42	36·40
Head	32·38	34·
Liver	27·44	22·
Smoked ham	45·76	60·
" meat	41·36	64·
Herring	31·32	21·
Sardines	29·86	93·

Of course the prices on these different articles of food in Germany would differ from those of Boston or New York, still the same principle would hold true as to their relative values, while many interesting deductions may be made from this table as to which foods afford the greatest amount of nutriment for the least outlay. In these days of enforced economy, when each individual is seeking to obtain value received for every dollar spent, it is of interest to know which article of food supply to purchase.

It is somewhat humiliating to be obliged to depend upon European experiments for facts concerning food values, even for analysis of grains, roots, and meats, when we have such an array of agricultural colleges, professors and other dependents upon the bounty of different States. It is well known to all intelligent persons that the analysis of corn or roots, or any other agricultural product raised in Germany, may be widely different from that of similar specimens grown in America, thus showing the great importance of more research, experiment, and analysis concerning practical, every-day matters in the agricultural institutions of this country. Considering the enormous outlays made by the people of every nation for their food, any means by which correct comparisons between cost and nutritive values can be instituted would seem to be really subjects worthy of Government attention and patronage.

There is as much foolish caste in food as exists in the human race itself; destroy the former and the prosperity of the people may be advanced, while the wealth of the nation may be augmented. Analysis of foods, official statements of comparisons of market values with nutritive values, will do this important work more speedily and more thoroughly than any other methods. Our State and national governments should take hold of this subject earnestly and vigorously, since the main element of cheap labor is cheap food, and this alone will so reduce the cost of our manufactured products as to enable this country to command foreign markets for our goods. The future prosperity of the country depends largely upon an increase of our exports in manufactured goods, as well as in raw materials, and thus give remunerative employment to thousands of idle hands.

To show that the people of any country will accept of cheap and nutritious food, when supplied in abundance and at rates within their means, I illustrate with the increased consumption per head of population in Great Britain, as shown through the importations of 1840 and of 1872. In 1840, there was imported of bacon and ham, to each inhabitant, one-tenth of a pound, in 1872 5·44 pounds; of butter in 1840 1·05 pound to each person, in 1872 3·9 pounds; of cheese in 1840 0·92 pound, in 1872 3·65 pounds; of grain in 1840 42·47 pounds, in 1872 102·8 pounds; of potatoes in 1840 ·01 pound, in 1872 21·06 pounds; and of rice in 1840 there was imported to each individual an average of nine-tenths of a pound, while in 1872 the average had increased to 13·7 pounds.

By an examination of Dr. Kœnig's table, given above, it will be seen that Indian corn is by far the cheapest grain, beans the cheapest vegetable, extra beef cheaper than poor or medium beef, and also cheaper than either veal, pork, or mutton. Milk, cheese, and butter, especially the two former, are economical articles of food. It will also be noted that the most nutritious of all grains, the oat, is the least desirable in an economical point of view, owing to its high market value when prepared for human food. This is probably owing to the small demand, as compared with that of wheat flour, which gives oatmeal an artificial value, and makes seven cents worth of nutrition in oatmeal cost twelve cents in Germany. This is all wrong, and the evil would soon correct itself if the use of oatmeal were as extended as wheat flour.

The same is true of flour or meal manufactured from corn. At present sources of supply it cannot be purchased any cheaper than wheat, and frequently costs more, while the market value of whole corn seldom exceeds one-half that of wheat. The dealers in and manufacturers of bolted meal, hominy, and other corn products are injuring their own interests by placing the cheapest and most nutritious staple in foods beyond the reach of the masses, or such thinking many as will not submit to imposition, thereby forcing people to purchase more expensive food in order to secure value received. It is highly important that the public at large should understand more fully the economies of food.—A. L. MURDOCK, *in Boston Cultivator.*

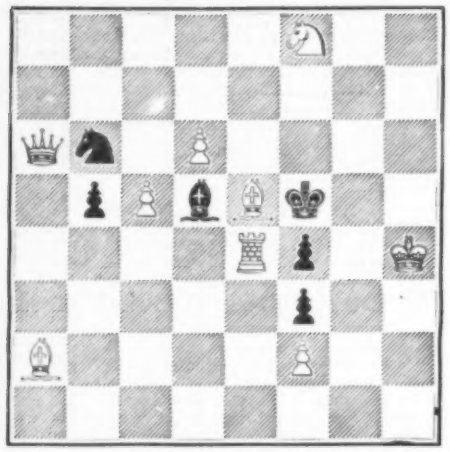
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 80. BY J. DOBRUSKY.

First Prize in the recent Bohemian Problem Competition.

Black.



White.

White to play and mate in three moves.

J. A. GRAVES, OF DELAWARE WATER GAP.

White to play and mate in 2 moves.
By J. B. MUNOZ.

IN presenting to our readers a capital portrait of Mr. Graves, of Delaware Water Gap, Pa., we feel that we are introducing to their notice one who through his own modesty has too long hid his light under a bushel, for, although Mr. Graves is but little known outside of the circle of his own friends, an examination of his problems shows the depth and skill of a master, and it is somewhat remarkable that one of our oldest and most original composers should be thus lost in the seclusion of his mountain home, where during the past ten or fifteen years he has hidden himself away.

Semi-occasionally, we hear an account of some votary of the game, while on a pleasure-seeking tour, who has received an unmerciful beating from the champion of the Kittatinny Mountains, and we occasionally coax a letter and problem from him that finds its way into print; but few if any of our problemists have heard from him since the production of the following clever two-move problem, which appeared about fifteen years ago, and went the rounds of the periodicals as a most remarkable and difficult problem.

ENIGMA No. 47.—BY J. A. GRAVES.

White.—K on Q B 7, Q Q R 8, Rs Q Kt 5 and K B 4, Bs K B 3 and Q Kt 4, Kts K R sq and Q B 5, Ps Q 3, K 2, K Kt 6, K R 5 and 6.

Black.—K on K 4, Kt K 5, Ps K 3 and 6, and K B 4.

White to play and mate in two moves.

OXFORD AND CAMBRIDGE CHESS MATCH.

MANY distinguished men of learning, among whom might be mentioned Franklin, Aaron Burr, and others, have expressed the opinion that the game of chess should be taught in our colleges, and the idea has been repeatedly advanced by influential professors through the medium of our magazines.

The editor of the *Holyoke Transcript* repeats the prophecy of Judge Meek, made at the Chess Congress of 1857, and says:

"The day will come when a professor of chess will hold a chair in our colleges and schools. We are sure the mental exercise is fully equal to the classics."

We can hardly say that we fully indorse such enthusiastic views, yet we would greatly rejoice to see the game of chess more generally recognized and practiced as an intellectual recreation in our public institutions, and think it might well be introduced as a national pastime, and would be a great improvement upon the boat-racing mania in which our college boys take so much pride.

There used to be a spirit of rivalry for chess supremacy between our colleges, but of late years there has been no effort made to revive it. In England, however, the interest seems to be increasing, and from the last number of the *Field*, we learn the following particulars of the recent contest between Oxford and Cambridge, in which Mr. Steinitz acted in the capacity of umpire.

The sixth annual Inter-University trial of chess skill took place at the rooms of the St. George's Chess Club, 20 King St., St. James, last month, between seven representatives on each side, and, like last year, the match was consummated in that unassuming semi-public character which well befits the studious nature of our game. The large majority of the two teams had assembled punctually at two o'clock. Five of the games were started at once, and the full number of boards was set going in about half an hour's time. Some modifications had taken place in the composition of the teams in comparison with the list previously published, and the two presidents of the respective University chess clubs also agreed before the commencement to alter some of the rules of last year's contest, to the effect that the maximum of games to be played by each pair was reduced to two, that no adjournment was to take place, and that the match should terminate at half past six o'clock precisely.

At the outset the probability of the victory was calculated by experts to be strongly in favor of the Cantabs, who were expected to muster their best strength, in order to neutralize their defeat of last year, which had also given their opponents the supremacy in the total score of the five previous matches, of which Oxford had won three and Cambridge two.

The following list gives the final result as well as the games of the contestants:

OXFORD.

1. F. M. Wright, Queen's	0	0
2. R. A. Germain, B.N.C., President	0	0
3. H. Lee, Worcester	0	1
4. E. H. Kinder, B.N.C.	1	0
5. C. Taylor, Ch. Ch		0
6. A. S. Perceval, Exeter	0	0
7. C. H. Malden, Trinity		0
Total		3

CAMBRIDGE.

1. J. N. Keynes, B.A., Fellow of Pembroke College	1	1
2. W. H. Gunston, St. John's	1	1
3. J. T. Chatto, Trinity	1	0
4. W. H. Blythe, Jesus	0	1
5. C. Chapman, St. John's		1
6. F. T. Sugden, Trinity Hall	1	1
7. W. Jennings, Corpus		1
Total		10

Problem No. 81 is by Herr Rudolph Wilmers, the distinguished pianist to the Court of Austria, whose reputation as a problemist as well as a musician has been world wide for a quarter of a century. It is a most remarkable fact that nearly all of our leading problemists are distinguished musicians; it is but a few days since we received programmes for concerts in which the names of W. A. Shinkman and Simon Fleischman appeared as leading stars.

JESSE A. GRAVES.

PETROFF'S DEFENSE.

MR. J. T. CHATTO (Cambridge).	MR. H. LEE (Oxford).
WHITE.	BLACK.
1. P to K 4	1. P to K 4
2. Kt to K B 3	2. Kt to K B 3
3. Kt x P	3. Q to K 2 (*a*)
4. P to Q 4	4. Kt x P
5. B to K 2 (*b*)	5. P to Q 4
6. Castles	6. Kt to Q 2
7. R to K sq (*c*)	7. Kt x Kt
8. P x Kt	8. Q x P
9. B to Q 3	9. B to Q 3
10. P to K Kt 3	10. Castles.
11. B x Kt (*d*)	11. P x B
12. Kt to Q B 3	12. P to K B 4
13. B to B 4	13. Q to K B 3
14. B x B	14. P x B
15. Kt to Kt 5	15. Q x P (*e*)
16. Kt x P	16. B to K 3
17. Q to K 2	17. B x Q R P (*f*)
18. Kt x Q Kt P (*g*)	18. Q x Kt
19. R x B	19. Q R to K sq (*h*)
20. K R to R sq	20. P to B 5
21. R x P	21. Q to B 3
22. Q to K Kt 4 (*i*)	22. P to Kt 3
23. K R to R 6	23. Q x P

White announced mate in three moves.

(*a*) Irregular and disadvantageous, as he blocks up his K B. The authorized and proper move is P to Q 3, preliminary to taking the P.

(*b*) There was no sufficient reason for not playing the B to Q 3 at once and thus gaining a move. The following would have been a probable continuation:

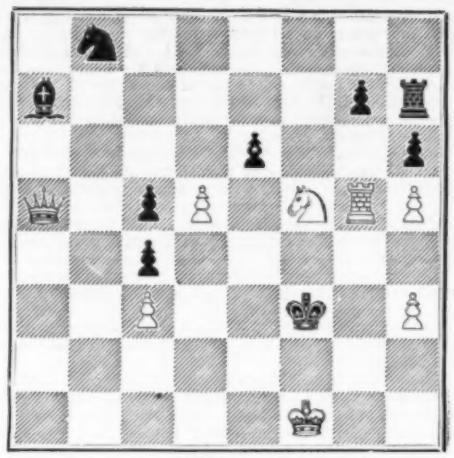
WHITE.	BLACK.
5. B to Q 3	5. P to K B 3
6. Q to R 5 ch	6. P to K Kt 3
7. Kt x Kt P	7. P x Kt
8. Q x R	8. Kt to Kt 6 dis ch
9. B to K 3	9. Kt x R
10. B x P ch	10. K to Q sq
11. Kt to Q B 3, and black's Kt has no escape	

(*c*) The sacrifice of the P ought not to have paid. It was simpler and better to exchange the Kt, followed by castling.

PROBLEM No. 81. BY R. WILMERS.

This Year's Prize of the German *Illustrirte Zeitung*.

Black.



White.

White to play and mate in five moves.

(*d*) It would have been useless to advance the P to K B 3, for black could well reply B to B 4 ch; whereupon white had nothing better than to interpose the B, and black would then exchange, followed by Q takes Q Kt P. If, in lieu of interposing, white ventured on moving the K to B sq, black could capture the R P, threatening mate in two moves.

(*e*) First weakness. It was better to play R to Q sq, and to hold the pawns together, until his advantage could be more visibly augmented.

(*f*) Again loosening his position. P to Q Kt 3 would have made his own lines safe, while the opponent would have had an additional weak P to defend.

(*g*) The right rejoinder, which much improves his powers of resistance.

(*h*) At any rate he ought never to have weakened the key to his position, the Q R P; and, if he meant to occupy the K file, he should have chosen the K R. But probably K R to Q sq was even better than either, and he might have kept two strings to his bow for the end game, for he could then either pursue the plan of advancing the Q R P, or to assert his superiority on the K side by degrees.

(*i*) All this is excellently played by white, who has fought an uphill battle very skillfully.

(*j*) White winds up a well-conducted attack with a brilliant termination. The finishing moves are evidently initiated by R x P ch, followed on the K playing in the corner by the other R taking R P ch.

SOLUTIONS TO PROBLEMS.

No. 74.—BY FRANK HEALY.

WHITE.	BLACK.
1. R to K 7	1. R x B
2. Kt to K 3	2. B x Kt
3. Kt to K 5	3. Moves
4. Kt or R mates.	
	1. B to K B 7
2. R x B	2. Moves
3. Kt to K 3 or 5	3. Moves
4. Mates.	
	1. P to K B 4
2. Kt to K 3	2. B x Kt
3. Kt to R 8	3. Moves
4. Kt mates.	

No. 75.—BY FRANK HEALY.

WHITE.	BLACK.
1. Q to Q B 8	1. R to Q R 2
2. Q to K Kt 4	2. Moves
3. Kt mates.	
	1. Kt to Q B 2
2. Q to Q Kt 7	2. Moves
3. Mates.	

LETTER "Y."—*Free Press* Tourney.

WHITE.	BLACK.
1. Q to Q B 5	1. R to Kt 4
2. B to K 6 ch	2. R x Q
3. B x P mate.	

ENIGMA No. 43.—BY F. HEALY.

WHITE.	BLACK.
1. K to K 7	1. K to K 5
2. R to Q 5	2. K x R
3. Q to Q 4 mate.	

ENIGMA No. 44.—BY F. HEALY.

WHITE.	BLACK.
1. K to Q B sq	1. P to Kt 5
2. K to Kt 2	2. K to Kt 4
3. B to R 5	3. K moves.
4. B mates.	

"This game an Indian Brahmin did invent,
The force of Eastern wisdom to express;
From whence the same to busy Europe sent,
The modern Lombards styled it pensive chess."
—*Dunham.*